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Wildlife of the Mackenzie Delta Region

A.M. Martell, D.M. Dickinson and L.M. Casselman

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LETTER OF TRANSMITTAL

The literature review of the Wildlife of the Mackenzie Delta was originally undertaken in 1974-75 by Dr. Arthur Martell, as a Research Associate at the Boreal Institute for Northern Studies under a contract from the Department of Indian and Northern Affairs.

The report resulting from this contract was submitted in 1976 to the Department of Indian and Northern Affairs. In 1978, permission to publish was released to the Boreal Institute for Northern Studies and the original manuscript was updated by Ms. Dawn Dickinson to include literature to 1978.

The Northwest Territories Department of Education expressed interest in publishing the manuscript as a text book. However, these negotiations did not come to pass and the Boreal Institute for Northern Studies decided to publish the manuscript in its Occasional Publications Series. The manuscript was again updated and the Boreal Institute for Northern Studies is now pleased provide this publication.

The time between the initial work and final publication may seem unduly long. However, it enhances the value of the updated publication in that there was intense interest in the area at the beginning, which then lapsed temporarily after the Berger Report on the Mackenzie Valley Pipeline, with its subsequent moratorium. There is now again great interest in the area from renewed resource development in the Mackenzie Delta region and it is hoped that this updated publication will be valuable to those concerned about the wildlife of the area.

The record would not be complete without acknowledging the contributions of others who particpated in this publication: Mrs. Geraldine Perry, who obtained and organized most of the literature cited; Mr. G. Lester and Mr. K. Bodden for the maps and figures; Mr. K. Bodden and Ms. R. Minion for compiling the Species Index; Ms. C. Mittelstadt for inputting the final manuscript into the computer; Dr. W.A. Fuller for refereeing the manuscript; to Ms. A. Moore for typing the original and arranging for the final printing; and to Mrs. G.A. Cooke for final editing and coordination of the manuscript.

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PREFACE

Wildlife has always been of major importance to the peoples of the Mackenzie Delta Region for domestic and commercial purposes. In its natural context of wild lands, it has also had a profound influence on the cultural evolution of the Inuit and Indian and is therefore not only of utilitarian interest, but forms the substance of "myth, legend, history and law".[1] For all but fifteen or so of the last several thousand years, until escalation of oil and gas exploration activites in the southeastern Beaufort Sea, wildlife was the mainstay of the Delta economy and it continues to be the principal renewable resource base. As such it assumes the economic position taken in more temperate regions of Canada by agriculture and forestry, with an economic potential measured in thousands of years rather than in the decades that are estimated for most oil and gas deposits. Many species of wildlife that occur in the Region are migratory and the importance of these can not be estimated, only within a regional context. Most birds and some mammals, notably whale and caribou, use the Delta Region for reproduction and feeding during the summer but spend the greater part of the year in other regions, they are therefore of value in both a utilitarian and a non-utilitarian sense to the peoples of more temperate regions in Canada and other countries.

The following report was written with the purpose of firstly synthesizing information from published historical accounts with that of more recent papers in an annotated list of all vertebrate wildlife species that occur or have been reported in the Delta Region, with a brief discussion of some of these species; and secondly, of providing a list of references that for the most part are readily available to the public. References to less easily obtained consultants reports and unpublished manuscript reports have been kept to a minimum.

One of the principal aims has been to make available biological information on wildlife of the Region to people who are not scientists but who, perhaps, have had some high school biology. Technical terms have been explained in a glossary at the end of the report. The customary citation of references in the text has been omitted to allow easier reading by a non-scientific audience, although it is appreciated that this may cause some inconvenience to biologists who wish to check sources of records for species, or other information, and have to search through the references at the end of each chapter. For a more detailed non-technical

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[1] Quoted from the judgement of Mr. Justice Brian Dickson in R vs Sutherland (1980) S.C.C.D. 6187-01. See also: Berger, Thomas R. 1981. Fragile freedoms. Clarke, Irwin & Co. Ltd., Toronto. pp.250-277

discussion of marine mammals and birds of the southeastern Beaufort Sea the reader is referred to Donald Blood's Birds and marine mammals [2]

Updating of the Wildlife of the Mackenzie Delta Regionmanuscript was originally completed in the spring of 1979 and all information given was current as of the end of 1978. It subsequently encountered numerous delays in reaching publication and in the spring of 1983 a few additional references to 1982 were added and some changes accordingly made in the text to include more recent information, where, for example, researchers had revised former population estimates.

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[2]Blood, D.A. 1977. Birds and marine mammals. The Beaufort Sea and the search for oil. Dept. Fisheries and the Environment, Ottawa. 124 p.

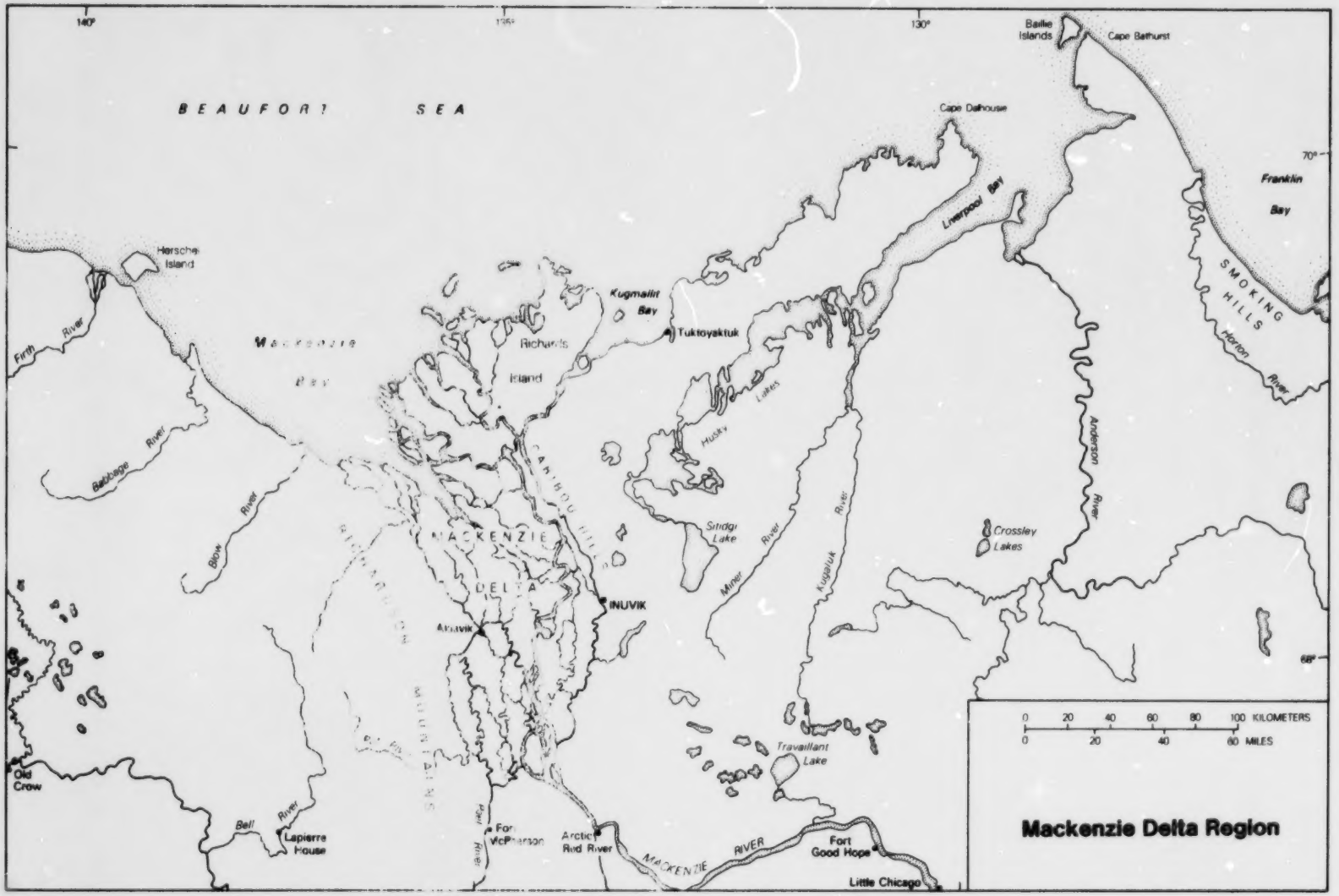

Figure 1. Mackenzie Delta Region

1. MACKENZIE DELTA REGION

1.1 Introduction

The Mackenzie River is one of the ten longest river systems in the world and the longest in Canada. It is unique among major Canadian rivers in that it flows north and discharges its relatively warm and nutrient-rich waters into the Arctic Ocean. The delta that has evolved over the years at the mouth of the Mackenzie forms an extensive interface of both land and fresh estuarine water. It is an interface that changes seasonally and annually according to spring flooding, ice movements and onshore, wind-driven storms, and it is characterized by a diversity of riparian vegetation in various successional stages. Deltas of large rivers in temperate and tropical regions are usually areas of prime agricultural land. In the North , productivity is expressed instead in seasonal abundance of various forms of wildlife. The diversity of landforms adjacent to the Delta and the resultant mosaic of plant communities provide a variety of habitats over a large area that are important to many different species of wildlife. Because this wide area is productive for wildlife it has traditionally been important to those peoples dependent on wildlife for subsistence. Many of these species are migratory and have also been traditionally important to peoples who live in other regions, other countries and even other continents. The area used by indigenous peoples of the Mackenzie Delta, as indicated by recent land-use maps and accounts, roughly corresponds to the area referred to in this report as the Mackenzie Delta Region. The boundaries of this Region run from Herschel Island southeast to Lapierre House, east to Little Chicago, northeast to the head of Franklin Bay, and west along the coastal waters of the southeastern Beaufort Sea to Herschel Island (Figure 1). The Old Crow Flats and the Porcupine River, although shown in Figure 1, are not included in the Mackenzie Delta Region. More detailed maps of the Region are provided in Appendices 1-4.

Documentation of the wildlife of the Delta Region began with the explorer Alexander Mackenzie in 1789. Some observations were also made by members of the Second Franklin Expedition, 1825-1826, and the Franklin Search Expeditions, 1848-1853. A number of explorers visited the Delta Region in the period 1889-1907, most of whom made observations on the wildlife of the Region, while several were concerned principally with collecting information on wildlife. In the period 1908-1918, two major expeditions were made to the

Delta Region - the Stefansson-Anderson Expedition of 1908-1912 and the Canadian Arctic Expedition of 1913-1918. Largely through the work of Rudolph Anderson, these expeditions gathered much basic information on the birds, mammals, and fish of the Region. Two other expeditions passed through the Delta Region in the early part of this century and made passing observations on the wildlife - the Gjoa Expedition of 1903-1907 and the Fifth Thule Expedition of 1921-1924. Between 1927 and 1935, A. Erling Porsild worked in the central part of the Delta Region and gathered the most comprehensive information to that time on the wildlife of the Region.

Although there was some fur trade in the Delta Region through old Fort Good Hope from 1823 to 1826, fur trade in the Region really only developed after the establishment of Peel's River Post (Fort McPherson) in 1840, Lapierre House in 1845, and Fort Anderson in 1861. The early fur traders often made detailed observations on the wildlife of the Region since some species were the basis of their livelihood. The most notable of these traders was Roderick MacFarlane who explored the Anderson River in 1857 and 1859 and established and operated Fort Anderson from 1861-1866. During this relatively short period, MacFarlane collected thousands of specimens of birds and mammals in the eastern part of the Delta Region. These collections formed much of the base of our knowledge of the wildlife of the Region.

Missionaries began activities in the Delta area about 1860, but the only missionary notable for his observations on wildlife was Father Emile Petitot who was active in the Region from 1865 to 1872. Although the whalers were primarily interested in bowhead whales, a few made some general observations on other wildlife during the whaling period of 1889-1910.

Until after the Second World War the works of MacFarlane, Anderson, and Porsild served as the primary references on the wildlife of the Delta Region. For the most part, these works were lists of the animals found in the Region and some observations of their natural history. During the following three decades, aerial surveys were used to estimate numbers of some species, and a few more detailed biological studies were made. However, so little was known of the wildlife of the Region that the environmental impact studies, initiated in 1972 in response to the proposed Mackenzie Valley Pipeline, were confined at first to collecting the simplest of base-line data. The integrated studies that subsequently made up the Beaufort Sea Project were initiated in response to offshore drilling for oil and gas, and added considerably more to the quality as well as quantity of knowledge of some wildlife species in the Region.

There have been no long-term studies at the level of ecosystems and this report reflects our lack of understanding of food chain relationships, multi-herbivore interactions and predator-prey-scavenging systems.

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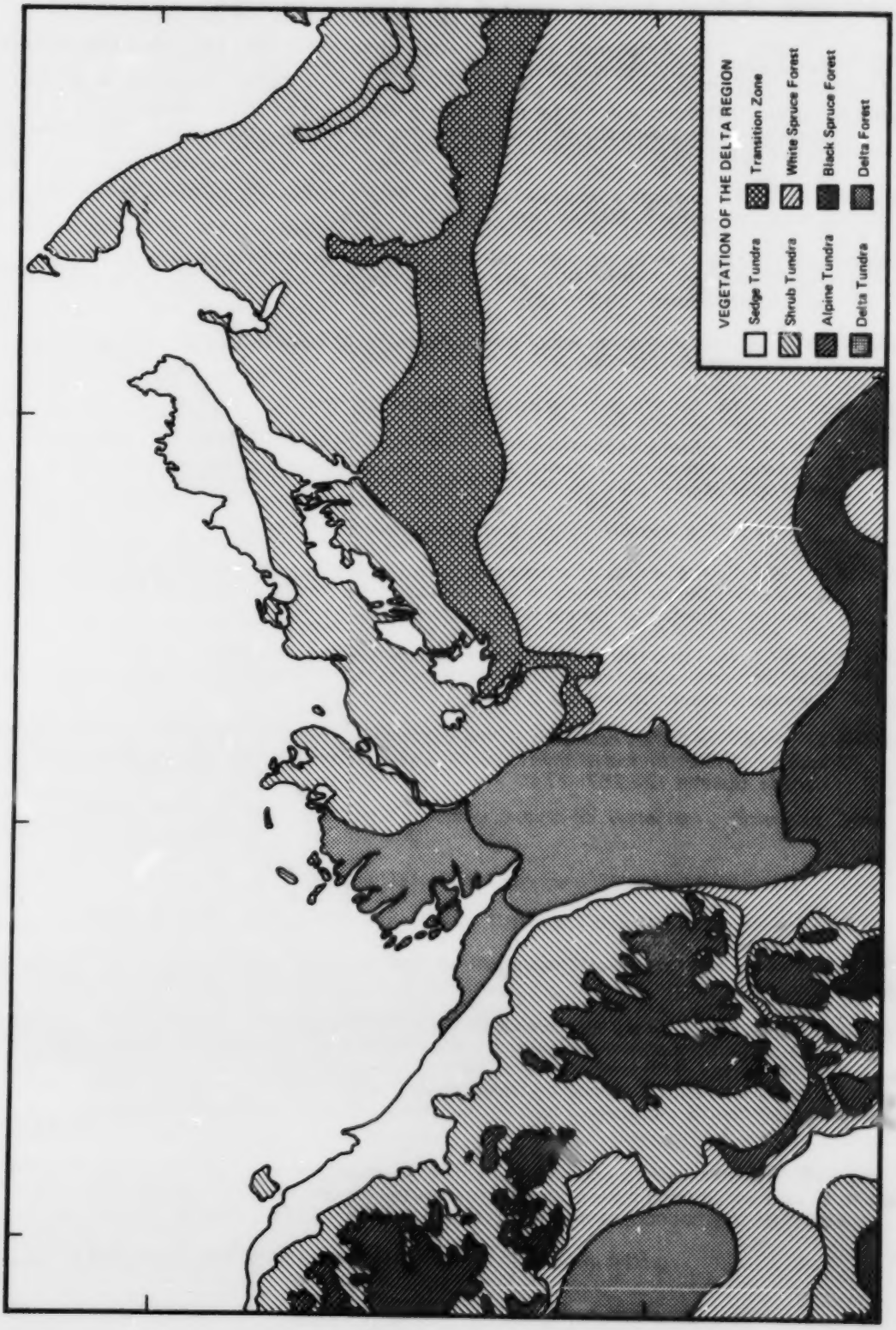
Figure 2. Vegetation of the Mackenzie Delta Region



2. VEGETATION OF THE MACKENZIE DELTA REGION

2.1 Introduction

The Mackenzie Delta Region is characterized by relatively abrupt changes in vegetation over six major physiographic units: mountain, upland, low coastal plain, delta, inland waters, and estuarine and coastal waters. Successional changes in some plant communities are maintained by seasonal flooding and in others are initiated by fire. The presence of permafrost has a major influence on terrestrial plant communities throughout the Region.

The general distribution of eight major vegetation types in the Region is shown in Figure 2 and a brief description of these types and of estuarine and coastal waters in relation to marine plants is given below. These descriptions are intended only as a general background to habitats for wildlife.

2.2 Estuarine and Coastal Waters

In the Delta Region the intertidal zone is narrow and subject to severe ice-scouring; it therefore supports few benthic marine plants (seaweeds). Communities of phytoplankton (small, free-floating or ice-attached marine plants) are not numerous in the Mackenzie estuary, primarily because of the high turbidity of silt-laden river water which limits the depth to which light can penetrate in summer and accordingly limits photosynthesis. At the edges of the warm, turbid river water, phytoplankton productivity is relatively high in summer because of greater light penetration in clearer water and because of nutrients carried by river water into the Beaufort Sea. In much of the Region the long period of ice cover, low temperatures and limited nutrients result in low productivity of phytoplankton. However, productivity can be relatively high during spring and summer in some locations and phytoplankton attached to the substrate of the undersurface of ice is adapted to photosynthesize at relatively low levels of light.

Polar pack ice, which varies in extent, but persists throughout the year, lies north of the Delta Region, although in some summers prevailing onshore winds may drive pack ice floes into onshore waters. Along the coast, landfast ice usually begins to form in late September or early October and does not begin to break up until June. Between pack ice and landfast ice there is a transition zone in which areas of open water may persist throughout some winters, or may form

early in spring. When relatively narrow and transient, these areas are called leads while those that are larger and more persistent are called polynyas. They are critical to the survival of marine mammals (which must surface to breathe air) and to migratory seabirds, waterfowl and shorebirds. Productivity of phytoplankton is greatest along leads and polynyas and in bays and lagoons along the coast of the Delta Region.

2.3 White Spruce Forest

The major forest type in the Delta Region is generally dominated by white spruce *(Picea glauca)*. On open slopes and hill tops and around lake shores, stands may be composed almost entirely of white spruce with a ground cover of lichens, while on poorly drained terrain black spruce *(Picea mariana)* and tamarack *(Larix laricina)* predominate. Trees are generally small, under 4 m (13 ft) tall, and are widely spaced. The ground surface is characterized by earth hummocks and trees grow either between or on the sides of the hummocks. Hummock tops are covered with lichens (mainly *Cladina, Cladonia,* and *Cetraria)* and depressions between hummocks contain sphagnum moss. The dominant shrubs are willows *(Salix* spp.), dwarf birch *(Betula glandulosa)*, and Labrador tea *(Ledum palustre)*.

Most stands are even aged, having been established after fire, which may be essential to the maintenance of forest cover over much of the area. Following fire, shrub communities return in about 15 years, while spruce trees may take 100–150 years to regrow. Regrowth of ground lichens is dependent on changes in microclimate that occur as trees become established. On warm, well-drained slopes successional stands of white birch *(Betula papyrifera)* and white spruce are found. The dominant shrubs in these stands are willows and soapberry *(Shepherdia canadensis)*. There are occasional stands which are of mixed age due to the absence of fire for several centuries, and in these stands some trees may be 200–280 years old.

In stream bottoms and floodplain areas, communities dominated by alder *(Alnus crispa)* and willows are common. On well-drained sites, stands of white spruce occur, and trees reach up to 15 m (50 ft) in height and may be up to 300 years old.

2.4 Black Spruce Forest

Black spruce forest with a lichen ground cover occurs along the Mackenzie River, and with a sedge tussock ground cover in the Porcupine and Bell rivers area. The latter form predominates on poorly drained, silty soils; tree cover is sparse and consists of small black spruce and some tamarack with a shrub layer of sparse willow and dwarf birch. Hummock tops are covered by sedge and cottongrass tussocks (mainly *Carex bigelowii* and *Eriophorum* spp.) and sphagnum moss forms the ground cover between hummocks.

2.5 Transition Zone

Between forest and tundra there is a narrow transition zone, which is shown in Figure 2 only in the area east of the Mackenzie Delta. Within this zone, sheltered creeks and stream beds support stands of white spruce while upland areas form a mosaic of scattered stands of white or black spruce and shrub tundra. Periodic fires tend to perpetuate tundra in this area where trees are under stress from low temperatures during the growing season, exposure to winds, and instability of permafrost soils. There are occasional stands, however, which appear undisturbed and are very old.

2.6 Sedge Tundra

The low Yukon Coastal Plain west of the Mackenzie Delta and the lowlands of the unglaciated tip of the Tuktoyaktuk Peninsula support extensive areas of sedge tundra. The sedge tundra of the Yukon Coastal Plain is dominated by sedge (*Carex* spp.) and cottongrass (*Eriophorum* spp.) tussocks. The tip of the Tuktoyaktuk Peninsula is covered with low-centred polygons and supports extensive sedge meadows with only scattered sedge and cottongrass tussock meadows. In both locations, willows are scattered and dwarf birch and Labrador tea are found on better drained sites which often support shrub tundra communities.

2.7 Shrub Tundra

Shrub tundra areas are generally dominated by low shrubs such as dwarf birch, Labrador tea, willow (mainly *Salix glauca*), alder, Lapland rosebay (*Rhododendron lapponicum*), and Lapland cassiope (*Cassiope tetragona*). Moist sheltered sites, especially near tree line, may

support dense stands of tall shrubs (2–3 m [6–10 ft]) while dry hilltops may support only scattered, low shrubs. There are also scattered sedge and cottongrass tussock meadows and sedge meadows within shrub tundra areas.

2.8 Alpine Tundra

In the Delta Region, alpine tundra is found only in the Richardson Mountains at elevations above shrub tundra. Alpine tundra is characterized by a sparse plant cover, largely made up of lichens and low-growing and cushion-form plants. At the highest elevations surfaces are bare except for crustose lichens and a few flowering plants. Some of the characteristic plants of alpine tundra are eight-petaled dryas (*Dryas octopetala*), moss campion (*Silene acaulis*), phlox (*Phlox sibirica*), diapensia (*Diapensia lapponica*), poppy (*Papaver* spp.), and the saxifrages (*Saxifraga* spp.).

2.9 Delta Forest and Tundra

The Mackenzie Delta is a low lying area containing the channels of the Mackenzie River, numerous lakes and interconnecting channels. The upper part of the Delta has many old floodplains, over 9 m (30 ft) above the mean summer low water level, poorly developed levees, and relatively stable channels. In the central part, levees are more common, and north of Aklavik and Inuvik their height decreases to only 3–6 m (10–20 ft) above the mean summer low water level. Channels tend to meander much more in this central part of the Delta and new land is constantly being formed through siltation. North of tree line, the lower Delta has levees of only 1–3 m (3–10 ft) above sea level and is flooded each year.

The upper Delta is forested with white spruce, but tree cover decreases from 40–50% at the head of the Delta to only about 20% at Inuvik and 10% at Aklavik. On the high floodplains and levees, stands of white and black spruce and tamarack occur. In these stands white spruce is dominant and trees may be up to 560 years old. The understory consists of shrubs, grasses, mosses and lichens. Low shores of channels and lakes are dominated by horsetails (*Equisetum fluviatile, E. arvense*), sedge (*Carex aquatilis*), and grass (*Arctophila fulva*). Above these bands are stands of willows (*Salix alaxensis, S. arbusculoides*). Alder grows above the zone of annual flooding, and above the bands of alder, taller willows (*Salix pulchra*) and balsam

poplar (*Populus balsamifera*) are often present. Lakes that are not flooded annually may have sedge bands in shallow water and extensive areas of floating and emergent aquatic plants (*Potamogeton, Menyanthes, Myriophyllum, Utricularia, Hippuris*).

The central part of the Delta forms a transition zone between forest and tundra and supports extensive areas of dense willow (*Salix richardsonii*) and alder. The lower lying areas are characterized by wet meadows of horsetails, sedges and grasses.

The lower Delta lies beyond tree line and contains large areas of buckbean (*Menyanthes trifoliata*) and wet meadows of horsetails, sedges and grasses. Higher ground supports sedge meadows (*Carex aquatilis*) with some willows (*Salix richardsonii, S. Glauca*).

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3. MAMMALS OF THE MACKENZIE DELTA REGION

3.1 Introduction

While studies of single species or populations of species have been made in the Delta Region there have been few long-term studies and no integrated studies of species in relation to each other. Many populations fluctuate widely in abundance over the years, and species reported to be common in certain areas in some years, may be very rare in the same areas in other years. Some species are highly mobile and most move seasonally to different areas or different habitats. Observations contained in historical records are valuable in indicating changes in abundance and distribution when compared with recent records. However, questions related to populations that fluctuate in abundance and vary in distribution clearly can only be answered by long-term research and integrated studies.

Fifty-four species of mammals have been recorded in the Delta Region; some of these are migratory, others have been recorded only rarely, and others are year round residents. There are reports of seven additional species, but their occurence in the Region has not been confirmed. Brief accounts are given of some marine, terrestrial and semi-aquatic mammals.

An annotated species list is given in which general distribution of animals is emphasized. The only previous complete list of mammals in the Region was compiled by Porsild in 1945. North American distribution and nomenclature are based on the reference works of Hall and Kelson(1959) and of Banfield(1974).

3.2 Beluga Whale

Introduction

The beluga [3] or white whale *(Delphinapterus leucas)* is a common summer visitor to the Delta Region. Recent distribution is similar to that observed by early explorers. Mackenzie saw belugas from Garry Island in mid-July 1789, and Franklin observed them in the same area in mid-August 1825. Franklin also saw a few whales in western Mackenzie Bay in early July 1826, but was told by hunters at Shingle Point that beluga would come in great numbers "with the following moon". Belugas were also sighted by early explorers in Liverpool Bay in early August

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[3]Beluga, or belukha, is an ancient name used by northern Russian fishermen and hunters.

1850 and near Cape Bathurst in mid-July 1825, mid-August 1848, and early September 1850.

Movements

Belugas winter in the Bering Sea and in spring migrate to the southeastern part of the Beaufort Sea along leads of open water. Satellite photographs taken in spring show a series of leads between landfast and pack ice from Herschel Island to the Cape Bathurst polynya, and off the west and south coasts of Banks Island. It is believed that most whales travel along this series of leads in most years. In Alaska, belugas have been observed to pass Point Hope in April and Point Barrow in early May, although the peak movement past Point Hope usually occurs in the first half of May. Murdoch reported that, at Point Barrow, in 1882 and 1883 "as soon as there was open water between the land-floe and the beach a large herd passed up to the northeast. About a week or ten days later another large herd of several hundred passed up each season, but these were all that were seen."

Belugas may arrive at the Bathurst polynya off Baillie Island by late May and may move either east or north. Stefansson, while camped on pack ice off the west coast of Banks Island, observed on 21 May 1914 "a school of beluga whales passing, northward bound along the lead. During the next two or three weeks we saw thousands of them." During June, belugas are found in the eastern Beaufort Sea and Amundsen Gulf and have been observed near Herschel Island and in inshore leads along the Yukon coast. Hunters at Kay Point told Franklin that the beluga come as soon as small leads open.

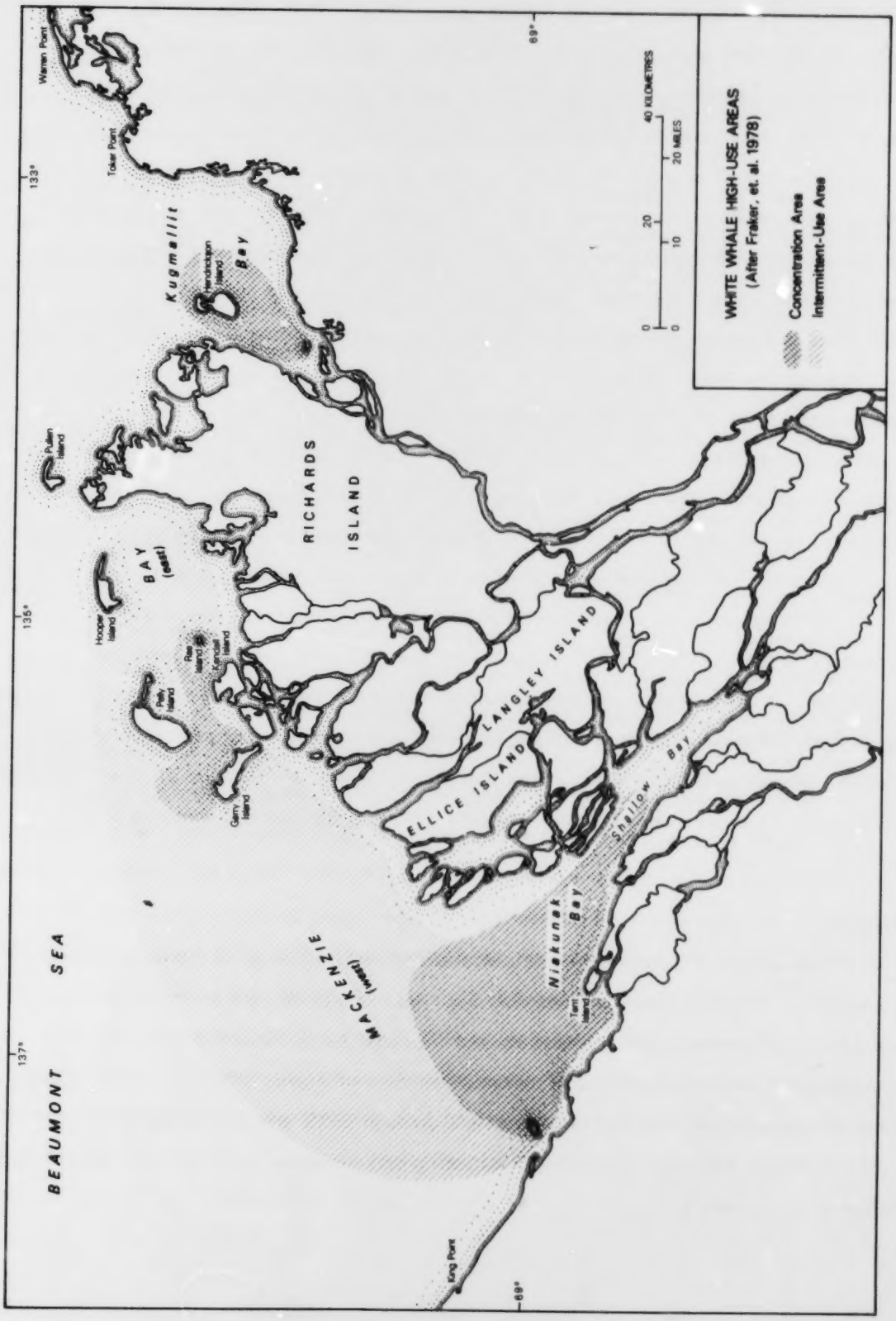
Following ice breakup, large numbers of beluga move into the estuarine waters of Mackenzie, Kugmallit, and Liverpool bays. Some may also enter Franklin Bay since Rasmussen reported that people living at the mouth of Horton River said that beluga come in as soon as the ice goes out. Porsild reported that beluga regularly ascended the larger branches of the Mackenzie River in July and August and that groups were frequently observed in East Channel up to Tununuk Point, and have been reported as far as Point Separation. In the last century, belugas have been reported ascending the Peel River to Fort McPherson and the Mackenzie River to Fort Good Hope. During open water belugas also regularly enter the Eskimo (Husky) Lakes and have been occasionally trapped by ice in years of early freeze-up. Such animals have subsequently died. There are relatively large numbers of fish in the Eskimo Lakes and belugas may use these lakes and Liverpool Bay principally for feeding.

The three most intensively used areas near the mouth of the Mackenzie are west Mackenzie Bay from Shallow Bay to Shingle Point, east Mackenzie Bay near Garry and Pelly islands, and the western part of Kugmallit Bay (Figure 3.). Whales concentrated in west Mackenzie Bay may move to east Mackenzie Bay during July and there is interchange between groups in the latter area and those of Kugmallit Bay. Both male and female, reproductive and nonreproductive animals are present in these areas which are considered to be critical for calving success. Although whales with newborn calves have been observed in non-estuarine waters in both western and eastern arctic regions, the frequency of non-estuarine calving is not known; nor is it known whether such calves have survival rates similar to, or lower than, those born in estuarine waters. Because of their small body size and thin layer of insulating blubber the energy expenditure of young calves in cold and wind-driven seas would be expected to be much higher than that of calves in warm sheltered estuaries. While all age classes may benefit from estuarine conditions, calves would benefit most. In early August belugas move out of the Mackenzie Estuary and may travel west towards Herschel Island or east towards Cape Bathurst and Baillie Island. Fall migration probably takes place in late August and September but routes are unknown. Belugas have been seen moving west past Herschel Island in August and September, and on 21 September 1972, 2,000 belugas were seen travelling west near Demarcation Point. It is possible that some belugas may occasionally winter in the Beaufort Sea in areas of open water or weak ice. There is no direct evidence for such overwintering, but observations of several hundred whales heading east in Amundsen Gulf on 27 September 1971 and of whales heading northeast in the eastern Beaufort Sea in January 1973 suggest that overwintering may sometimes occur.

Numbers

The number of beluga that use the Mackenzie Delta Region varies from year to year depending on ice conditions in the Beaufort Sea. Heavy ice in the northern and eastern parts of the summer range may displace whales toward the Delta. Ice conditions may also hinder movement to the Delta. Estimates of maximum numbers of whales in the Mackenzie Estuary have been made from aerial surveys from 1972 through 1979, and have varied from 1,500-2,000 in 1972 to 7,000 in 1979, excluding dark-coloured juveniles which are difficult to see in turbid waters.

Figure 3. White Whale High Use Areas



Growth and Age

The beluga populations of the world can be divided into three size groups. The smallest whales are found in western Hudson Bay, the White Sea and Bristol Bay, Alaska; medium size whales are found in all other Canadian localities and in the Kara and Barents seas; and the largest belugas are found off west Greenland and in the Sea of Okhotsk. Adult male belugas in the Delta Region are about 4.1 m (13.5 ft) long and weigh about 1075 kg (2370 lbs) and adult females are about 3.6 m (12 ft) long and weigh about 675 kg (1488 lbs). Maximum size is reached at about fifteen to twenty years of age.

The age of belugas is determined by counting the number of layers of dentine in the teeth. It is believed that two layers are deposited each year but the rate of attrition from wear of these layers is highly variable and the age of adults may therefore be underestimated from use of this technique.

At birth, belugas are about 1.5 m (5 ft) in length and are dark brown in colour but quickly change to a dark blue-grey. In subsequent years they become paler until they are completely white. Whitening in females begins at about six years of age and is complete by eleven years, while in males it begins near seven years and is complete by nine years.

Reproduction

Females reach sexual maturity at about five years and males at about seven to nine years. Mating takes place in spring and the young are born about fourteen months later. The young are nursed for one to two years although they are partially weaned at one year. Overlap of pregnancy and lactation is rare. Only about 25% of female belugas have a calf every two years; the remainder have one calf every three years. There are no data available on survival of calves or their recruitment into the breeding population.

Food Habits

In the Beaufort Sea beluga feed principally on fish, squid and crustaceans. In both offshore and some nearshore areas arctic cod are probably a major food resource; other fish species include burbot (loche), whitefish, inconnu and smelt. Examination of the stomachs of whales killed by Inuit has provided most of the data on food and feeding in the Mackenzie Estuary. Many stomachs were empty, or nearly so, indicating that adults do not feed much while

in the estuary. However, some Inuit hunters believe that whales often expel stomach contents during the chase.

Hunting

Traditionally belugas have been hunted each summer by some of the Inuit of the Delta Region. The Kigirktarugmiut hunted in west Mackenzie Bay and the Kupugmiut and Kittegaryumiut hunted near the mouth of East Channel. Harvests were reportedly much higher in the late 1800's than in recent years. Whales are still hunted principally in the shallow waters of their concentration areas in the Mackenzie Estuary.

Records of the number of whales killed and recovered near the Mackenzie Estuary (Table 1) indicate that about 210 beluga were taken in 1954, about 94 annually between 1959 and 1966, and about 134 annually between 1970 and 1978. Anderson reported that about 200 were taken in the estuary in 1909 but in 1910 "only a small number appeared." In 1913, 48 beluga were taken at Tent Island and 52 at East Whitefish Station. Porsild noted that about 24 whales, a "normal" catch, were taken by the Kittigamiut people in 1927. Records and observations indicate that harvests have fluctuated over the years, but recent harvests are likely lower than those in the late 19th century when beluga were also harvested at Baillie Island.

Not all of the whales that are wounded or killed are retrieved, due to the difficulty of following a single whale within a pod and the fact that dead whales, if not harpooned, sink quickly into the silt laden waters. About 31% (23–50%) of animals shot are lost. Assuming that those lost are dead or subsequently die, and assuming an average loss of 31%, about 194 whales would be killed annually to produce a mean annual harvest of 134.

3.3 Bowhead Whale

Introduction

Bowhead whales *(Balaena mysticetus)*, as their name indicates, are distinguished by their strangely shaped and disproportionately large heads. Formerly, they were prized by whalers for their baleen (whalebone), the amount of which, from one large whale, was worth $8,000 to $10,000 in 1893. In addition, their carcasses yielded large quantities of oil and they were easily killed and retrieved. There are three major groups of bowheads: the Spitzbergen stock, which was hunted nearly to extinction in the seventeenth century; the West Greenland stock, which

Table 1. Numbers of Belugas Recently Harvested Near the Mackenzie Delta

Year	West Whitefish Station	Kendall Island	Kittigazuit and East Whitefish Station	Tuktoyaktuk	Total
1954	68	24-26	94	14	200-225
1959	7	17	30	*nd	54-145
1960	17	nd	nd	nd	nd
1961	20	52	16	nd	nd
1962	1	33	11	30	75-85
1963	nd	94	nd	33	nd
1964	nd	nd	15	30	nd
1965	6	21	8	35	70
1966	9	14	13	56	96
1959-66 Mean	10	38	116	37	86-101
1970	30	nd	nd	75	nd
1971	30	nd	49	3	82
1972	33	4	31-35	45	113
1973	20	7	58-63	87	165-177
1974	30-35	2	49-50	25-40	120-122
1975	29	3	60	50	142
1976	32	12	59	49	152
1977	26	30	32	60	148
1978	30	10	35	52	127
1970-78 Mean	29	10	47	50	132-136

*nd - no data

was hunted nearly to extinction in the eighteenth century; and the North Pacific (Bering-Chukchi) stock, which was heavily hunted in the nineteenth century, until a sudden decline in the use of whalebone made further hunting uneconomical. A portion of the North Pacific stock continues to summer in the Delta Region.

Movements

Bowheads winter in the Bering Sea as far north as the edge of the pack ice about the Aleutian and Kurile islands. They migrate northward as the pack ice breaks up and some may reach Point Hope, Alaska by the end of March. This migration passes Point Hope throughout April and May, and occasionally into June. Bowheads have been seen swimming together with belugas in the same leads off the west coast of Alaska and are believed to use the same migration routes to the Beaufort Sea. The majority of bowheads move into the Chukchi Sea and

the western Beaufort Sea to summer, but a few summer in the eastern Beaufort Sea and Amundsen Gulf. Bowheads have been observed to reach the west coast of Banks Island by mid-May, and Baillie Island by the end of May. In summer, bowheads are widely distributed in the eastern Beaufort Sea, but are probably most common between southern Banks Island and the mainland coast near Franklin Bay. Although better able to break ice than belugas, their distribution is also affected by ice conditions.

The first recorded sighting of bowhead whales in the Delta Region was by Franklin who saw them from Garry Island on 16 August 1825. Hunters camped at Kay Point told Franklin that bowheads come shortly after the ice goes out, and other early explorers reported seeing them from mid-July through early September along the coast of Tuktoyaktuk Peninsula, near Cape Bathurst and in Franklin Bay. MacFarlane reported bowheads in leads in Franklin Bay in late June 1862 and 1864 and Anderson noted that they are sometimes seen in Franklin Bay in early June and as late as September. Whalers in the Beaufort Sea made the first kill of the season between late June and early August, usually near Baillie Island or Cape Bathurst. Early records indicate a distribution that corresponds with that obtained from recent observations.

In early fall bowheads migrate west out of the Delta Region, some travel offshore, while others move slowly along the coast and appear to feed as they travel. Bowheads have been observed passing Point Barrow from late August through September and the Beaufort Sea group may join the Chukchi Sea group before moving south. There have been several sightings of whales moving along the Yukon coast during the first three weeks of September and whalers usually made their last catches of the season near Herschel Island in late September. The last sightings of bowheads in the eastern Beaufort Sea were on 25 September in 1894, and on 27 September in 1895.

Numbers

Bowheads have been protected from commercial hunting since the 1935 International Convention on Whaling. They are classed as an endangered species by the International Union for the Conservation of Nature (IUCN), and in the Beaufort Sea may only be taken by permit by indigenous peoples. A few have been taken from Alaska, none from the Delta Region, and it is thought that the Beaufort Sea group is slowly increasing. At present, the number of bowheads that summer in the Beaufort Sea is not known.

Bowheads are social animals and are usually found in small groups. Larger groups occur when they are migrating, or in areas where food is abundant. Groups of up to fifteen animals were reported in Franklin Bay in 1850 and groups of up to thirty-two individuals have been seen regularly in the Delta Region in recent years. A group of one hundred migrating bowheads was seen in Bering Strait in July 1974.

During storms bowheads occasionally become stranded and die. The two most recent strandings in the Delta Region were near Warren Point in 1973 and 1974. The remains of four strandings from previous years have been found along the coasts of the Tuktoyaktuk Peninsula. The only predator of the bowhead, besides man, is the killer whale *(Orcinus orca)* which is not common in the Delta Region.

Growth and Age

Adult bowheads are normally 15-18 m (49-59 ft), long, rarely reaching lengths of 19.8-21 m (65-69 ft), and weigh over 50,000 kg (110,230 lbs). Males are shorter than females, but have larger heads - about 39% of the total length compared with 35% in females. The huge mouths contain about 720 baleen plates. The largest bowhead recorded from the Beaufort Sea was taken in 1900 and had baleen plates up to 3.7 m (12.2 ft) long, weighing 1,270 kg (2,800 lbs). It is believed that bowheads may reach almost forty years of age.

Reproduction

Almost nothing is known about reproduction in this species. Mating is thought to occur from June through August and birth of single calves follows in nine to ten months, from February to May. In this event calving would occur prior to or during spring migration. The length of the nursing period is not known.

Food Habits

Bowheads feed primarily on zooplankton (small free-floating invertebrates) which they obtain by filtering large quantities of water through hundreds of baleen plates as they swim along with their mouths open. Examination of stomach contents has shown that larger invertebrates from the benthic, or near benthic, zone (substrate or shallow water zones) are also taken. Some competition for food with ringed seals may occur.

Whaling

Traditionally, some of the Inuit of the Delta Region hunted bowhead each summer, probably taking small, immature animals. The Kigirktarugmiut living west of the Mackenzie Delta and the Kupugmiut and Kittegaryumiut living in and somewhat east of the Mackenzie Delta probably hunted only beluga, but the Nuvorugmiut living on the Tuktoyaktuk Peninsula and the Avvagmiut living on the Bathurst Peninsula also hunted bowhead. Richardson encountered bowhead hunters at Cape Bathurst on 11 August 1848 and reported: "In some summers they kill two black whales, very rarely three, and sometimes they are altogether unsuccessful." McClure reported that hunters at Warren Point in August 1850 had taken three bowheads that season, and MacFarlane noted that, in the 1860's, the Anderson River Inuit succeeded most seasons in killing one bowhead, but seldom as many as two. Petitot met an old hunter in 1868 who had killed seven bowheads in over fifty years as a hunter. Clearly the hunting pressure on the eastern Beaufort Sea bowhead population by Inuit was minimal, in contrast to the impact of the American whalers.

Although American whalers had been hunting bowhead north of the Bering Strait since 1819, it was not until 1888 that the first whaler reached Barter Island, Alaska, and one whale boat from Point Barrow reached Mackenzie Bay. In 1889, seven whaling ships reached Herschel Island and were anchored there on 11 August, but only two bowheads were taken that season. However, the numbers of whales they saw encouraged more ships to return the following year and the *Grampus, Mary D. Hume* and *Nicoline* wintered at Herschel Island in 1890-91.[4]

After 1895 whalers ranged further east and wintered east of Herschel Island. Two ships were trapped by ice and wintered at Shingle Point in 1896-97. Whaling ships wintered first at Langton Bay in 1897-98, and at Baillie Island in 1898-99. Between 1890 and 1910 a total of at least ninety-six ships wintered in the Delta region: at least seventy at Herschel Island, fifteen at Cape Bathurst and Baillie Island, eight at Langton Bay, one at Toker Point, and two at Shingle Point (Table 2). Over-wintering reached a peak in 1894-96 when fifteen and thirteen ships remained at Herschel Island during the two winters. The number of whalers in the Delta Region declined markedly after 1906, when cheap substitutes for whalebone were found and the price dropped to forty cents a pound from five dollars a few years earlier. This soon made Arctic whaling unprofitable and saved the North Pacific stock from being as heavily exploited as the other

[4]Anderson (1913, 1937) reported that the first whalers reached Herschel Island in 1888 and that the first wintering was 1889-90; however, this much quoted reference appears to be incorrect.

Table 2. Numbers of Whaling Ships Wintering in the Delta Region, 1888-1910. (After Bockstoce and Batchelder, 1977)

Winter	Herschel Island	Cape Bathurst, Baillie Island	Langton Bay	Shingle Point	Toker Point	Mackenzie Bay
1888-89	0					1
1889-90	0					0
1890-91	3					0
1891-92	1					0
1892-93	4					0
1893-94	7					0
1894-95	15					0
1895-96	13					0
1896-97	3			2		0
1897-98	2		4	0		0
1898-99	1	1	0	0		0
1899-1900	0	3	1	0		0
1900-01	0	5	0	0		0
1901-02	2(?)	0	1(?)	0		0
1902-03	2	0	0	0		0
1903-04	4	0	0	0		0
1904-05	4	0	2	0		0
1905-06	6	4	0	0	1	0
1906-07	2(?)	0	0	0	0	0
1907-08	1	0	0	0	0	0
1908-09	0	0	0	0	0	0
1909-10	0	2	0	0	0	0

bowhead groups.

In 1908, Inspector Jarvis of the Royal North-West Mounted Police at Herschel Island estimated that 1,345 bowheads were killed in Canadian waters between 1889 and 1907. This figure is about two thirds of the total catch of the Arctic Whaling Fleet for 1889-1904, and may be accurate since most of the whaling was done in the eastern Beaufort Sea at that time. Records indicate that at least another 100 bowheads were taken in the Delta Region between 1908 and 1915. Therefore, in only twenty-seven years, almost 1,500 bowheads were taken in the eastern Beaufort Sea.

3.4 Seals

Introduction

Eight species of seals have been recorded from the Delta Region but six of these are uncommon or very rare in the area. The two common seals are the ringed seal *(Phoca hispida)*

and the bearded seal (*Erignathus barbatus*). As recently as ten to fifteen years ago large numbers of seals were harvested in the Delta Region, principally at Herschel Island and Cape Bathurst, and were used for dog food. In the last few years, however, relatively few have been taken, although further east, in Amundsen Gulf, seals remain an important resource.

3.5 Ringed Seal

Distribution and Movements

Ringed seals in the Delta Region are presently believed to be part of a highly mobile population which ranges east through Amundsen Gulf; west along the Yukon and northern Alaskan coasts; and north along the west coast of Banks Island. Part of the population is resident year round in the Delta Region, and local distribution throughout most of the year is determined by ice conditions. During winter, mature seals concentrate wherever breathing holes may be maintained in landfast ice, and where pressure ridges and accumulated snow provide favourable conditions for construction of birth and other lairs. These conditions are usually found along the coast east of the Mackenzie Estuary, and include Franklin and Liverpool bays. Non-breeding seals overwinter at the edge of landfast ice adjacent to leads, while other immature seals migrate westward out of the Delta Region to overwinter.

From late May to early June seals haul out on landfast ice in the vicinity of breathing holes or leads, and remain on the ice surface for varying lengths of time. During this period they undergo an annual moult and spend relatively little time feeding. In late June and early July ringed seals have been observed migrating north along the northwestern coast of Alaska and into the Beaufort Sea for the open water period. Several hundred seals have been observed near Herschel Island in August and September. Distribution of seals during the period of open water is probably related to the relative abundance of food, although in some summers, areas of open water may be limited by persistent ice.

Numbers

Numbers of ringed seals estimated from aerial surveys made in June in the Delta Region, Amundsen Gulf, and off the west coast of Banks Island, declined from about 49,000 in 1974 to about 26,000 in 1975. These numbers include only those animals hauled out at the time of survey, and were not corrected for those under the ice. The magnitude of this decline is

confirmed by evidence of reduced productivity and subsequent declines in predator populations; reduced numbers of birth lairs; and reduced frequency of underwater vocalization by seals. The decline in numbers appears to have been due to the particularly heavy ice conditions during the winter of 1973–74. Numbers remained low in 1976 and 1977, increased to about 61,000 in 1978 and declined again to about 37,000 in 1979. Large-scale movements of seals among areas may have been involved in the decline in 1975 and were likely responsible for the increase in 1978.

Growth and Age

Newborn pups are about 65 cm (2 ft) in length and weigh about 4.5 kg (10 lb), their pelts are white, but within six weeks pups moult to a silver and dark grey pelt. The pelts of adults are dark grey along the back and are patterned with white rings. In the Delta Region, adult male seals weigh about 47 kg (104 lb) and adult females weigh about 41 kg (90 lb). Seals taken at Herschel Island are, on an average, slightly larger than those from central and southern Baffin Island, but smaller than those from Foxe Basin, northern Baffin Island and Eureka.

The age of seals is determined from growth characteristics of lower canine teeth. Very few ringed seals live more than thirty years.

Reproduction

Male seals become sexually mature at about seven years of age. The majority of females usually become mature by six years, although some may mature as early as four years of age. Most females that are six years and older breed annually, although this may not always be the case. Marked variation between years in the percentage of females breeding (as estimated by ovulation rates) has been recorded in the Delta Region.

Pups are born between late March and early April in a birth lair on landfast ice and are nursed for six to eight weeks. The lair is either hollowed out under thick snow or is a natural cavity between rough pressure ridge ice and is entered from the water through a breathing hole. The breeding season is from mid-March to mid-May. Females that have given birth may ovulate shortly afterwards and breed at that time. The fertilized egg does not implant in the uterus for about three months. This delayed implantation results in delayed growth of the embryo until after females have completed lactation and moulting, during which time energy expenditure is very high.

Food Habits

The diet of ringed seals consists mainly of zooplankton during summer and polar cod during winter. Concentrations of ringed seals have been associated with concentrations of polar cod. Some benthic crustaceans and bottom dwelling fish are also eaten on occasion.

Limiting Factors

Hunting by man and predation by polar bear and arctic fox are major causes of ringed seal mortality. Both polar bears and foxes take pups from birth lairs in early spring and bears also hunt during the ice season at leads of open water. Bears take subadults more frequently than adults. The extent to which food availability is limiting is not known. In some years ice and snow conditions may limit penetration of sunlight resulting in reduced growth of phytoplankton and consequently reduced productivity of zooplankton and fish. In 1974, when heavy onshore ice conditions prevailed in the Delta Region, seals were found in poor physical condition and few females produced young in either that year or the following year.

3.6 Bearded Seal

Distribution and Movements

Bearded seals (or square flippers) are year-round residents in the eastern Beaufort Sea. However, little is known of their movements, and part or most of the population may migrate out of the Delta Region in fall. In winter and spring they are associated with open leads and follow seasonal inshore-offshore movements of the ice edge. They are associated with shallow waters and have been observed in areas of landfast ice in the same vicinity as ringed seals. During summer they are relatively common in some estuaries and deltas. They occasionally ascend the Mackenzie River to the head of the delta and a few seals have regularly ascended the Anderson River as far as the inner delta. Distribution during open water is probably determined by relative abundance of food. Bearded seals are relatively common around Herschel and Baillie islands, Nicolson Peninsula, and in Liverpool and Franklin bays where substrate and water conditions are favourable for benthic invertebrates. In river deltas, along the coast, and in the Eskimo Lakes, bearded seals have been observed to haul out and rest on beaches or on promontories near deep water.

During the same aerial surveys flown between 1974 and 1979 to assess distribution and numbers of ringed seals, estimated numbers of bearded seals declined from 3,072 in 1974 to 1,389 in 1975. As with ringed seals, these estimates only include animals that were hauled out at the time of the survey. Numbers remained low in 1976 and 1977, increased to 3,109 in 1978 and declined to 2,056 in 1979. The changes in total numbers were similar to those for ringed seals and the factors involved in the changes were likely the same.

Growth and Age

Newborn pups average about 1.2 m (4 ft) in length and weigh about 34 kg (75 lb). They are nursed for twelve to eighteen days – a shorter period than ringed seals – but gain weight rapidly and weigh about 85 kg (187 lb) by the time they are weaned. Mature animals are about 2.2 m (7.2 ft) in length but growth continues after sexual maturation and older individuals may exceed 2.4 m (8 ft). Weight varies seasonally and winter weight may exceed 318 kg (700 lb).

At birth, pups are greyish–brown with patches of white, but within a few weeks they moult to a silver–grey pelt. The pelts of adults are dark grey along the back and silver–grey along the belly. The age of bearded seals has been determined from growth ridges on the claws of their flippers, but more recently from growth characteristics of their upper canine teeth.

Reproduction

In the eastern Arctic, males become sexually mature at about seven years and females at about six years, although a small percentage mature at the age of five years. However, in the Bering Sea, 60% of the five–year–old females examined were mature and the majority of mature females were pregnant, which suggests that females breed every year. In the eastern Arctic, however, mature females appear to conceive only in alternate years. Reproductive potential of bearded seals would therefore be much lower than that of ringed seals, at least in the eastern Arctic. There are no comparable data available for bearded seals in the Delta Region, although small samples in 1974 and 1975 indicated that ovulation rates varied between years.

Pups are born on the ice from mid–March to early May. Unlike ringed seals, bearded seals do not construct birth lairs. The peak breeding season occurs from mid–April to mid–May and implantation of the fertilized egg is delayed for about two and a half months. Bearded seals undergo an annual moult during the same period as ringed seals, and haul out on the ice for varying lengths of time during this period.

Food Habits

Bearded seals feed largely on benthic invertebrates; crabs, shrimps, clams and mussels are major components of their diet. In the eastern Beaufort Sea bearded seals were observed commonly in June on ice over waters of 25–75 m in depth.

Limiting Factors

Hunting by man and predation by polar bears are major causes of bearded seal mortality. Bears take subadults more commonly than adults; they take adults relatively infrequently except when seal populations are low. Shifting ice causing leads to close in winter, and increased ice thickness may result in seals being unable to gain access to air, either through breathing holes or from open water. There are no data on mortality caused directly by such ice conditions. Killer whales are known to take bearded seal but this species is uncommon in the Delta Region. Reproductive potential is severely limited by late sexual maturation and low birth rate.

3.7 Polar Bear

Introduction

Concern over declining numbers of polar bear *(Ursus maritimus)* throughout northern circumpolar regions led Canada, Denmark, Norway, the United States and the Soviet Union to initiate a program of co-operative studies, in 1968, through the International Union for the Conservation of Nature (IUCN). Subsequently, Canada, among other nations, signed an Agreement on the Conservation of Polar Bear in 1973. In the western Canadian Arctic a continuing program of research was started in 1970 by the Canadian Wildlife Service.

Distribution and Movements

From freeze-up in the fall to spring breakup polar bears are distributed throughout the southeastern Beaufort Sea and Amundsen Gulf according to types of ice formation. Bears concentrate along offshore ice adjacent to series of leads and on unstable ice especially in the vicinity of the Cape Bathurst polynya. Ice that is relatively free of snow cover is preferred. Subadult seals are also concentrated in those areas and are fairly readily accessible to bears. Female bears with cubs have been observed principally on landfast ice from which adult male bears were absent, and where adult ringed seals maintain breathing holes and construct birth lairs. Ringed seal pups are taken by bears that break into birth lairs from the snow surface.

Mature seals are also taken on landfast ice during their moulting period. Following breakup, bears stay with drifting ice and may then be found offshore or inshore as the ice moves according to prevailing winds. They are able to hunt seals effectively only on ice or in open water adjacent to ice. Because of the persistence of pack ice in the Beaufort Sea, bears are not often found inland in the Delta Region during the open water season.

During winter, coastal land is used by pregnant females for maternity dens. However, during the last ten years, only four maternity dens have been located along the mainland in the Delta Region – at Herschel, Hooper and Pullen islands and at Nuvorak Point. While there appear to be many suitable denning sites, it is believed that, with extensive human travel along the coast and with widespread use of firearms, most bears with an affinity for denning sites in that area have probably been killed. Denning on pack ice has been confirmed in the Alaskan part of the Beaufort Sea and it is assumed that females that do not den on Banks and western Victoria islands probably den on pack ice.

Movement of tagged bears between Alaska and the Delta Region has been documented, but the amount of interchange appears to be limited and data indicate that bears moved to Alaska when seal populations in the Delta Region decline. The Delta Region, Amundsen Gulf, Banks Island and the western half of Victoria Island are included in Management Zone H, and the polar bear population within this zone appears to be fairly discrete.

Numbers

Numbers of polar bear have been estimated by tranquilizing and marking bears in various ways for later identification from hunting kills, recaptures, or subsequent sightings. Population estimates are derived from the ratio of unmarked to marked bears. The number of bears in Management Zone H is estimated to have declined from approximately 1,800 in 1972–74 to approximately 1,200 in 1974–77.

Reproduction and Growth

The age of polar bears is determined by growth characteristics of the premolar teeth. From data obtained from October 1970 through July 1975 it was found that the majority of females in the eastern Beaufort Sea became sexually mature at the age of five years. A small proportion of three- and four-year-old females conceived but generally bore a single cub, whereas older females more often produced twins. In the eastern Arctic the majority of

females have been found to conceive first at four years of age. The reproductive potential of bears in the Delta Region therefore appears to be very low and is probably influenced by nutritional state since productivity of bears was markedly reduced in 1975, following the decline in numbers of seals.

Mating takes place about May and there is a delay of about four months before implantation. In the fall, pregnant females construct large dens in deep snowdrifts and during the time of occupancy reduce energy expenditure by greatly reducing activity and metabolic rate. The young are blind, hairless, about 25 cm (10 in) long, and about 450 g (1 lb) in weight at birth. By mid-March to mid-April the cubs are mature enough to leave the coastal dens with their mother and travel to sea ice. Cubs are weaned at approximately two and a half years of age and may stay with their mothers for another year. Unless cubs die, females normally breed about every third year. When full grown, adult males range in weight from 450-550 kg (1,000-1,200 lb) and adult females range from 180-270 kg (400-600 lb). In the wild, polar bears may live up to about twenty-five years.

Food Habits

Although bears are opportunistic (they will scavenge, take seabirds and waterfowl and their eggs, and occasionally some plants), seals are their staple food. During years of high ringed seal productivity at least half of the seals taken by bears in spring are pups; subadults form a large proportion of seals killed in the pack ice or along the floe edge. Although fewer bearded seals are taken than ringed seals, they are an important component of the kill because of their greater size. When seals are relatively abundant, bears tend to consume only the fat (blubber) from their kills and leave the remainder, which has lower caloric value, for scavengers. Scavenging of seal carcasses by other bears may be common, and such carcasses are also an important source of food to arctic foxes, ravens and gulls.

Limiting Factors

Because the polar bear is a top level carnivore in the marine food chain, its productivity in the Delta Region is ultimately limited by the relatively low primary productivity of the Beaufort Sea. Its reproductive potential is very low and appears to be related to food availability. The average litter size of females six years and older is 1.66, while the average conception rate of this age group is about 43%. Cub mortality may be high in years of low seal productivity and, in

addition, cubs may be cannibalized by adult males. Hunting by man is limited by quotas set for Inuit communities. In the Delta Region, more females and subadults than adult males have been taken because female bears prefer landfast ice in spring and are therefore in close proximity to hunting camps.

3.8 Arctic Fox

Introduction

There have been no systematic studies of the arctic fox (*Alopex lagopus*) in the Delta Region. From surveys along the proposed pipeline routes across the Yukon coastal plain and the Mackenzie Delta, parts of the Mackenzie Delta Region have been classified as to their importance as arctic fox habitat. Information on predation and scavenging by foxes in the Region has resulted from studies of birds, seals and polar bears.

Distribution and Movements

The arctic fox is commonly found in tundra, forest-tundra and on landfast ice. In the Mackenzie Delta Region foxes appear to be associated with coastal areas from Herschel Island to Shallow Bay, Kendall and Hooper islands, parts of the Tuktoyaktuk Peninsula and from Cape Dalhousie to Bathurst Peninsula. There is some overlap in distribution of arctic and red foxes. Both species require well-drained stable soils for den construction at sites where snow melt occurs early, but arctic foxes avoid areas of dense shrub. On Kendall Island arctic fox dens were found on flat open plains and in high banks along the coast. Dens have also been found on pingos on islands in the Delta.

Movements of arctic foxes are poorly understood. Animals are known to migrate regularly from western Banks Island out to sea ice in winter and return in spring. In the Delta Region similar migrations are indicated by the traditional location of numerous traplines on sea ice in the outer delta, off the Tuktoyaktuk Peninsula, and perhaps to a minor extent along the Yukon coast to Herschel Island. In other regions, mass movements of arctic foxes onto sea ice and deep into the boreal forest have been recorded in some winters.

Numbers

There are no estimates of numbers of arctic foxes in the Mackenzie Delta Region. Data obtained from fur export tax returns from Aklavik, Inuvik and Tuktoyaktuk, and from Banks Island

Table 3. Harvest of Arctic Fox According to Fur Export Tax Returns from the Mackenzie Delta Region and Banks Island from 1968-69 to 1976-77.

Years	Aklavik	Inuvik	Tuktoyaktuk	Total	Sachs Harbour
1968-69	12	506	539	1057	1226
1969-70	20	228	353	601	1420
1970-71	93	1098	476	1667	2815
1971-72	56	493	2070	2619	2008
1972-73	85	175	856	1116	2702
1973-74	90	1411	580	2081	6014
1974-75	59	996	1066	2121	3272
1975-76	62	920	910	1892	3760
1976-77	66	1156	1725	2947	5931

provide rough estimates of relative abundance over a series of years (Table 3). In making such estimates it must be assumed that the number of pelts used domestically and the time and effort spent trapping are more or less constant each year. Indices of relative abundance between regions may also be obtained from counts of active dens. Along the Yukon coastal area densities of active dens were found to be: 1 den/13 km² (5 mi²) on Herschel Island; 1 den/47 km² (18 mi²) from Demarcation Point to Phillips Bay; and 1 den/746 km² (288 mi²) east of Phillips Bay. These densities compare with 1 den/10.1 km² in part of Banks Island and 1 den/36 km² (14 mi²) in the Aberdeen Lake area of the District of Keewatin.

Reproduction and Growth

The arctic fox has a high reproductive potential. Most females are sexually mature at three years of age, although some females may first conceive as yearlings or two-year-olds. Males may also become sexually mature as yearlings. Based on placental scar counts from mature females in the central Keewatin and Resolute Bay areas, the average litter size is 10.6, although the number of weaned whelps varies markedly among years. Intra-uterine and post natal mortality may be very high in years when food is scarce. In the western Canadian Arctic males and females form pairs in late February and March, and mating takes place about April. Dens that have been excavated during previous summers are reoccupied, since new dens cannot be made until the ground thaws. Young are born after a gestation period of about fifty days and first emerge from the den about July.

Adult foxes weigh about 3 kg (6.6 lb). In summer their fur is predominantly brown, but is often quite patchy according to the stage of moult. In the fall they moult again either to a white or blue phase. The blue phase may vary from blue-black to pearl grey and is rare in the Delta Region; only about 3% of the arctic foxes traded at Fort Anderson in 1861 and 1862 were blue phase, and in 1976-77 only about 0.4% of those traded in the Delta Region were blue phase.

Food Habits

Arctic foxes are top level carnivores in marine and terrestrial food chains. They are predators of ringed seal pups, lemmings and other small rodents, and of birds, eggs and nestlings. During winter they may rely heavily on carrion, especially that of seal and caribou. They are efficient scavengers, are attracted to garbage, and, whether scavenging or hunting, are highly opportunistic. Availability of food varies according to region, season and fluctuations of prey populations. Lemmings appear to be an important component of the diet of denning foxes even in coastal regions; and, in the interior, the abundance of lemmings is critical to their reproductive success. In central Keewatin arctic foxes are known to follow migrating caribou in the fall and to feed on caribou carrion. There is no evidence of association of arctic foxes with caribou herds in the Mackenzie Delta Region and seals, killed by polar bear, are probably the most important winter food resource for foxes, although the extent of dependency is not known.

Limiting Factors

Although the arctic fox has a high reproductive potential, realization of that potential is contingent on abundance of food. Reproductive failure, and high mortality of whelps, probably due to intrasibling strife, occur when prey populations are low. The size of weaned litters has been found to be directly proportional to food availability. In some areas, lack of suitable denning sites may limit fox numbers. The relative importance of predation by wolves, polar bears, grizzly bears and of avian predation of cubs at den sites is not known. Trapping is a major cause of mortality. Foxes are also subject to canine diseases and epidemics of rabies have occurred when fox populations are high.

3.9 Caribou

Introduction

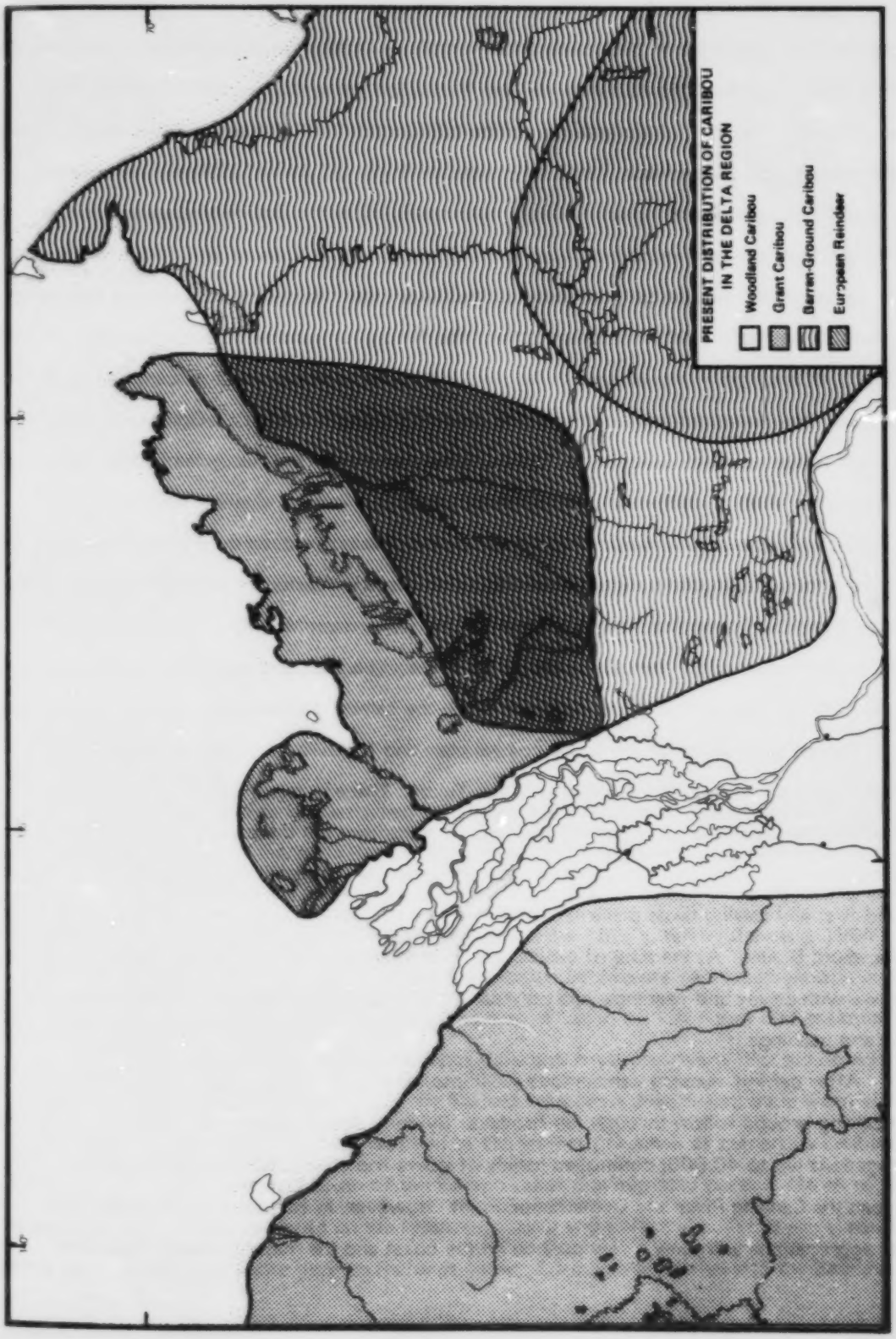
There are four subspecies of caribou (*Rangifer tarandus*) in the Delta Region; three are native to the Region and one was introduced. The three indigenous subspecies are barren-ground caribou (*Rangifer tarandus groenlandicus*), which ranges east of the Mackenzie River, Grant caribou (*Rangifer tarandus granti*), which ranges west of the Mackenzie River, and woodland caribou (*Rangifer tarandus caribou*), which occurs in small groups in some forested parts of the Region. Reindeer (*Rangifer tarandus tarandus*) are Eurasian in origin, were introduced to the Region in 1935, and are semi-domesticated. The distribution of caribou and reindeer in the Region is shown in Figure 4. Caribou known as the Bluenose Herd are of the barren-ground subspecies and those known as the Porcupine Herd are of the Grant subspecies. Reindeer are presently held under private ownership on the Mackenzie Reindeer Grazing Preserve. However, since their introduction several hundred animals have strayed; some of them have reverted to a wild state and exist as feral populations; others have been absorbed into the Bluenose Herd and may have bred with caribou from that herd, although the breeding seasons are a month apart. Tagged reindeer have been reported within the Porcupine Herd. There have been no systematic studies of feral reindeer, woodland caribou, or of intergrades of barren-ground caribou and reindeer, and barren-ground caribou and woodland caribou. Caribou of the Porcupine and Bluenose herds make extensive semi-annual migrations and these groups are much closer in physical and behavioural characteristics to each other than to either woodland caribou or to reindeer. The Porcupine Herd is the subject of continuing studies and a study of the Bluenose Herd was undertaken from 1974 to 1975. The following description is, therefore, confined to Grant and barren-ground caribou.

Grant Caribou

The Porcupine Caribou Herd occupies a range which stretches from the Peel River drainage west to the Chandalar River drainage in Alaska, and from Dawson City north to the Beaufort Sea. Historical records suggest that the Herd has occupied that range for at least the last 200 years, although the specific areas used each winter have been quite variable. Annual migration routes, however, seem to be traditional.

From about 1900 until the 1940's the Herd reportedly increased in numbers and expanded wintering areas westward into the Brooks Range in Alaska. A sharp decline in numbers

Figure 4 Present Distribution of Caribou Herds in the Delta Region



was reported in the mid 1940's, but the herd has probably increased somewhat since the decline. In 1957 and again in 1964 substantial numbers of caribou were reported to emigrate to the Porcupine Herd from the Fortymile Herd in Alaska, but the evidence is tenuous. None of these changes in numbers or emigrations can be confirmed. The Porcupine Herd presently numbers about 100,000 animals, based on counts in 1972, 1977 and 1979, and appears stable.

The Porcupine Herd typically winters below tree line in the Ogilvie Mountains and the upper Peel River drainage in the Yukon, or in the Chandalar River drainage in Alaska. However, wintering has occurred in virtually all areas of the range at some time. In all but one winter between 1970-71 and 1977-78, over 90% of the Porcupine Herd wintered in Canada; in 1972-73, 80% of the Herd wintered in Alaska. However, the actual areas of Canadian winter range used have varied among years. In most winters some portion of the Ogilvie Mountain - Peel River Range has been used, but in 1974-75 the majority of the Herd was found in the northern Richardson Mountains and on the Arctic coast.

The spring migration is fairly regular each year. Caribou move north to the coast along three main routes; along the valleys of several arctic rivers in Alaska, through the western Ogilvie Mountains and Old Crow, and along the crests of the Richardson Mountains. The actual number of animals using any given route depends on the wintering areas used that year. Caribou begin moving north in late March or early April and reach the calving grounds by late May or early June.

Calving takes place on the arctic coastal plain and foothills of the British Mountains from the Canning River, Alaska, to the Babbage River, Yukon. There is some annual variation in the portions of the calving ground that are used most intensively, but the calving ground is still the area most consistently used by caribou in their annual cycle. Pregnant cows reach the calving ground first and calving takes place from the last week of May through the middle of June, with a peak about 5 June. At the time of calving the herd is segregated into nursery bands composed of cows with calves and yearlings, and non-calving groups composed of bulls, non-pregnant cows and yearlings.

After calving, nursery bands move west into Alaska along the coastal plain and the non-calving groups follow through the foothills. By early July of most years, huge post-calving aggregations (up to 40,000) composed mainly of cows and calves, form along the coast between the Canning River and Demarcation Point. However, in some years the bands form loose aggregations with only a few caribou on the coast and the majority inland. Bulls and

yearlings move into Alaska in late June and early July. Usually most bulls and yearlings enter Alaska, but in some years the majority remain in northern Yukon.

In the first half of July most of the herd moves eastward through the British Mountains and by mid to late July reaches the northern Richardson Mountains. At least in some years, large concentrations of caribou may be found in the vicinity of Bonnet Lake, Yukon. During this fly-season, groups travel at night and aggregate on ridges or in high valleys during the day. Toward the end of July or early August, the density of mosquitoes declines and the large, closely knit summer group breaks up as most caribou move back to Alaska, roughly along tree line. A smaller number of animals (4,000-10,000) remains in the northern Richardson Mountains. The group that moves west reaches the vicinity of Arctic Village by late August and then drifts back eastward into the Yukon. Very little is known of these summer movements, especially those that occur in August.

By mid-September a general movement southward to the winter range has begun. Some caribou move south through the Richardson Mountains, but the majority move through the Old Crow Flats. The rate of migration may be slow in good weather or rapid if heavy snowfalls occur. In some years many caribou move west into Alaska in mid-October, after crossing the Porcupine River. The rut occurs in late October during the migration. By November most of the Porcupine Herd is on its winter range.

Barren-ground Caribou

The Bluenose Herd ranges between the Mackenzie and Coppermine rivers north of Great Bear Lake to the coast. In the Delta Region, early explorers reported seeing caribou on the Caribou Hills, on Ellice, Kendall, and Richards islands and along the Tuktoyaktuk and Bathurst peninsulas. Caribou were still common in these areas in the 1890's, but by the early 1900's were declining rapidly, probably due to heavy exploitation by whalers. Although caribou were still reported to be numerous in the Eskimo Lakes area in 1902, by 1927 they had essentially disappeared from the country between the Mackenzie and Anderson rivers. Porsild noted that: "In many places on the Caribou Hills and in the Eskimo Lake basin deep-worn trails were still clearly visible in 1927 and 1928, and testified to the former presence of numerous caribou." This group of caribou wintered south of the Eskimo Lakes and migrated north in March or April. However, a few caribou wintered on the Mackenzie Delta and along the coast to Anderson River; some caribou spent the entire year on Richards Island. Caribou that moved into the Bathurst

Peninsula area in spring were reported to migrate along the Anderson River in fall, and to winter in the forests to the south.

Caribou were scarce throughout the Delta Region in 1929, and were still scarce in 1942–43 between the Mackenzie River and Langton Bay, but numerous east of Langton Bay. Over the last fifteen to twenty years the Bluenose Herd has expanded its range, and presently numbers about 35,000 animals. The extension of range and the age structure of the Herd indicate an expanding population.

The distribution of the Bluenose Herd in winter appears to vary according to snow conditions. In the winter of 1973–74 all of the forested winter range appeared to have been used and a number of caribou also wintered on the tundra, whereas in the winter of 1974–75, which was characterized by early and deep snow, only part of the forest was used and very few animals wintered on the tundra. Spring migratory routes and times of migration also differed between the two years. The major calving areas in the Delta Region are near Cape Bathurst and the Smoking Hills of the Bathurst Peninsula area, although calving has also occurred between the Anderson River and headwaters of the Mason River. Post-calving concentration areas are not yet well documented, although in July 1975 post-calving concentrations were observed as far south as the north shore of Great Bear Lake, and during August many caribou were seen between the Anderson and Horton rivers north of Lac Rendez-vous. Movements of caribou from the Bluenose Herd west of the Kugaluk River indicate that the Herd is reoccupying its former range, and in 1974 some animals were observed to move west across the Mackenzie River in the Thunder River area. Migratory movements of the Bluenose Herd may, at least in some years, be less extensive than those of the Porcupine Herd and the energetic demands of long migrations may, therefore, be less for the Bluenose Herd than for the Porcupine Herd.

Impact of Whalers on Caribou Herds

Between 1890 and 1910, at least seventy whaling ships wintered at Herschel Island and twenty-seven ships wintered between Toker Point and Langton Bay (Table 2). Each of these ships had about a fifty-man crew, about ten to twelve Inuit hunters who supplied the ship with meat, and twenty to sixty dogs.

Caribou were the major source of meat; Dall sheep, moose, seal, snowshoe hare, ptarmigan, and waterfowl were supplemental sources. Stone noted that fifteen ships at Herschel Island one winter used over 136,000 kg (300,000 lb) of caribou meat, that four ships

at Langton Bay in 1897–98 used 40,824 kg (90,000 lb), and that one ship at Cape Bathurst in 1898–99 used 18,144 kg (40,000 lb). This is an average of 9,752 kg (21,500 lb) of caribou per ship per winter. Cook recorded the amount of meat brought to his ship when wintering at Herschel Island and reported using the following amounts of caribou, sheep and moose: 1895–96, 4,067 kg (8,966 lb); 1903–04, 5,967 kg (13,154 lb); 1904–05, 6,488 kg (14,303 lb); 1905–06, 5,875 kg (12,952 lb). Over 1,021 kg (2,250 lb) of caribou meat was received by one ship at Baillie Island between 25 April and 14 June 1901, and one ship and the Royal North–West Mounted Police post used 3,509 kg (7,736 lb) of sheep and caribou at Herschel Island in 1907–08. In addition, five ships wintering at Herschel Island in 1905–06 used over 22,680 kg (50,000 lb) of meat. These estimates show an overall average of 5,181 kg (11,422 lb) of meat per ship per winter, and an average of 6,110 kg (13,470 lb) of meat per ship per winter for the period 1903–1906, when the records appear most complete.

Because of the distances from which game were hunted from the ships and the fuel needed by the hunters, usually only the "saddle" of the caribou was brought in; these saddles weighed an average of between 14.3 kg (31.5 lb) and 15 kg (33 lb) each. Accordingly, 428 to 652 caribou were used per ship per winter. Between 1890 and 1908, whalers wintering at Herschel Island are estimated to have harvested between 29,000 and 44,000 caribou primarily from the Porcupine Herd, and between 1897 and 1910 whalers wintering east of the Mackenzie Delta are estimated to have harvested between 11,000 and 17,000 caribou, primarily from the Bluenose Herd. These estimates are higher than those of Bockstoce who assumed that entire dressed caribou were brought to the ships; he also did not consider the fuel requirements of the hunters.

In order to evaluate the effect of harvesting on any herd, it is necessary to know the size of the herd, the sex and age class of animals taken, reproductive success and recruitment, and the extent of mortality from other causes on different age classes in each year. This information is fragmentary today and totally unavailable for the period when whaling ships operated in the Beaufort Sea. However, many animals from tundra wintering groups were taken, and it is therefore probable that the sharp decline of caribou east of the Delta and in the Richardson Mountains in the early 1900's, was caused principally by the impact of whalers' harvests. Lang observed that after the whaling period people had to travel far inland to hunt caribou, and not until 1926 did caribou reappear in the foothills west of the Mackenzie Delta.

Limiting Factors

At present there are inadequate data on human harvests and no data on the effect of weather, nutritional status, wolf predation and infectious diseases on the mortality of different sex and age groups of the Porcupine and Bluenose herds.

Females may become sexually mature at seventeen months, but the only comprehensive data so far available for barren-ground caribou indicate that most females do not conceive until forty-one months. The age at which females conceive is probably most closely related to energetic demands and nutritional status, and probably varies among herds and among years. Very limited data from studies of the Bluenose Herd suggest that a greater proportion of females may conceive at twenty-nine months than in the Kaminuriak Herd of the eastern Arctic. No data are presently available for the Porcupine Herd. It is expected that continuing studies of the Porcupine Herd will provide necessary data on limiting factors. Clearly, further studies are required to obtain such data for the Bluenose Herd.

3.10 Beaver

Distribution and Numbers

The beaver *(Castor canadensis)* occurs in association with lakes and rivers throughout the forests of the Delta Region and is probably most numerous in the vicinity of the Peel and Mackenzie rivers and in the upper Mackenzie Delta. There are records of its occurrence beyond tree line east of the Mackenzie Delta and in the Anderson River delta. Signs of old beaver workings have also been observed on Richards Island. From habitat surveys in the Region it was found that good quality habitat was very limited; only one area, west of Fort McPherson, was classed as high quality beaver habitat. In the Mackenzie Delta widely fluctuating water levels, together with low sprouting vigour of willows, result in relatively poor habitat over much of this area.

Mackenzie reported that Indians encountered in 1789 near the outlet of Travaillant Lake did not seem to know the beaver. Of other later travellers on the lower Mackenzie River and Delta only Richardson, in 1828, and MacFarlane, in 1857, reported seeing beaver. MacFarlane also observed beaver in the Fort Anderson area in the 1860's. Lang reported that 1867 was the last year in which beaver were taken in large numbers from the Mackenzie Delta, which implies that beaver were relatively numerous in some preceding years. However, they were reported to

be fairly numerous again from 1900–1910, after which populations declined and beaver were very scarce by 1925 and for at least two decades thereafter.

In 1940, a beaver sanctuary was established in the Mackenzie Delta. With protection, populations increased and by 1953 densities of colonies were reported at 0.4/linear km (0.2/mi) inside the Sanctuary and 0.2/linear km (0.1/mi) outside the Sanctuary in similar habitat. Average densities for colonies in the Fort McPherson – Arctic Red River area were reported to be 0.1–0.2/km² (0.04–0.08/mi²). In the highest quality habitat in the Delta densities of colonies remained stable at 0.3–0.4/km² (0.12–0.15/mi²) from 1962 to 1965, but declined to 0.1/km² (0.04/mi²) in 1968 and 1969. This decline was associated with depletion of available food, although trapping quotas were increased and a spring hunt was initiated in 1965. During the 1962–1969 study of beaver in the Delta the average number of beaver per colony was found to be four to five, and as high as six in good quality habitat. In 1972, beaver populations in the Region were still low; there is no published information on their present status.

Reproduction

Little is known of the reproduction of beaver in the Delta Region. Beaver are monogamous and pairs remain together; breeding probably takes place from March through April and the young are born from about mid–June through July. Under favourable conditions females may breed as yearlings, but more usually as two–year–olds. Males probably first breed at two years of age. The average number of embryos per pregnant female is 2.5 in the Delta, but many resorbing embryos and barren females have been observed, and the average number of kits and yearlings per adult pair was found to be only 1.0 and 0.2 respectively. Two–year–olds normally leave the colony in early summer prior to the birth of the young, although when food supplies become depleted whole colonies may disperse during summer to occupy other areas.

Denning and Food Habits

In the Mackenzie Delta, beaver excavate dens in banks of lakes and rivers at sites protected from erosion by wave action and adjacent to food supplies. Water depth at den entrances is between 2.1 and 3.6 m (7–12 ft) and bank height above mean water level is at least 1.5 m (5 ft) to accommodate the den. In some areas beaver may control water levels by building dams across streams or at the outlets of lakes.

Beaver feed extensively during summer on leaves and shoots of willow (*Salix* spp.) and poplar (*Populus balsamifera*) and during the rest of the year on the bark of those trees. Depending on availability, the bark of other trees may also be eaten. Beaver probably also use the rhizomes of water lily (*Nuphar* spp.) extensively where they are available. About mid to late August beaver start to build food caches for winter. These caches are partially submerged rafts of branches and saplings anchored close to their dens. They are visible from the air and are used to identify active colonies during aerial surveys. Willow is the principal component of food rafts in the Region, although other species of trees may be stored according to availability and preference. During winter, beaver feed from their rafts and also decrease their activity, food intake, and metabolic rate, so that energy expenditure is reduced and fat deposits may be maintained until spring. Growth is restricted to the short summer season and is very rapid; adult size is reached at four years of age and equals that of beaver in Alberta and Saskatchewan.

Limiting Factors

In the Mackenzie Delta Region beaver are at the extreme northern limits of their range; reproductive potential is low, and mortality of yearlings and dispersing two-year-olds is high, which results in low recruitment of young to the breeding population. Beaver are also constrained by long periods of ice cover, limited denning sites and relatively low quality food throughout most of the year. Slow growth rates of trees result in slow regeneration of depleted food resources. Other limiting factors include winter trapping and spring shooting of beaver. The extent of predation from other causes and the incidence of disease is not known.

3.11 Muskrat

Distribution and Numbers

The muskrat (*Ondatra zibethicus*) occurs in association with lakes throughout the forest of the Region, but is probably most abundant in the upper Mackenzie Delta. Muskrats are also found in some tundra lakes, especially in the lower Mackenzie and Anderson river deltas. They have been observed in the Richardson Mountains west of Fort McPherson at 914 m (3,000 ft) above sea level, and near the coast from Tent Island to Toker Point. From surveys in the Region, the best quality habitat was found in the upper Mackenzie Delta, with good quality habitat in the vicinity of the Peel and Mackenzie rivers. The remainder of the Region was classed as poor

muskrat habitat. Muskrat numbers fluctuate widely and possibly cyclically in the Region. Populations in the Mackenzie Delta have been the subject of several studies, including one long term study from 1962–1969. From live-trapping data during this period it was found that populations declined sharply from 1962 to 1963 and continued to decline until 1965. Numbers remained low in 1966, increased slightly in 1967 and rose to a peak in 1968, and then dropped markedly again by the summer of 1969.

Reproduction

Muskrats generally breed during spring breakup and breeding may be delayed in years when breakup is late. Young adults disperse widely at the start of the breeding season to find territories of their own and during summer muskrats occupy virtually all water bodies. Usually all overwintered females produce one litter, and about half breed again and produce a second litter later in the summer. Some young-of-the-year females may become sexually mature, breed and produce one litter in the season of their birth. The average number of embryos per pregnant female is 8.4–8.6, and only in one year over the study period, when numbers were low, was a high incidence of resorption of embryos observed. However, mortality of newborn young appears to be high since, after leaving the den, the average number of young per adult female was observed to be 4.3. Juvenile mortality was estimated to be 50% by January and 80%–90% by spring breakup. While reproductive potential is high, survival of young and recruitment into the breeding population appears to be very low, at least in some years.

Denning and Food Habits

In the Delta Region muskrats excavate bank dens with entrances below water level in lakes where food is readily available. In spring they depend on submerged aquatic plants and particularly on the rhizomes of horsetail (*Equisetum* spp.). As water levels drop during summer they feed on emergent plants, including horsetail and sedges (*Carex* spp.). In winter they extend their foraging distance under ice by constructing pushups. These pushups are hollow mounds of vegetation which rise above the surface of the ice and are covered by snow during winter; muskrats enter pushups through holes in the ice which must be kept open. During winter, muskrats feed on submerged aquatic plants in the vicinity of their dens and pushups. The air temperature in pushups has been measured at about −1° C (30°–31° F) when muskrats are absent, and about 2°–4° C (36°–40° F) when they are present. Up to seven muskrats may use the

same pushup, but a given individual does not apparently use more than four pushups. However, trappers have taken as many as thirteen muskrats from a single pushup, as muskrats from other areas move in when the residents are removed.

Water depth is critical to the survival of muskrat in winter, and lakes less than 1 m deep (3.3 ft) are too shallow for overwintering. Relatively small lakes in forested areas are sheltered from wind and accumulate snow, the insulation of which reduces ice thickness and allows maximum water depth. However, if heavy accumulation occurs early in the season successive overflow ice layers are formed, which increase ice thickness and sometimes seal pushups. Where water at shoreline is frozen to the bottom, muskrats can often still burrow through the mud, or use old beaver channels to reach areas of deeper water containing their pushups and submerged vegetation. However, lakes of moderate depth with steep banks form the best winter habitat.

Limiting Factors

In the Mackenzie Delta Region muskrat populations may be limited by food availability, suitable denning sites and the freezing of shallow lakes. While reproductive potential is relatively high, survival of young, especially over winter, appears to be very low. The extent of trapping and spring shooting varies in different parts of the Region; predation from other causes is low. The incidence of disease is also low in comparison with that in southern populations which achieve higher densities.

3.12 Annotated List of Species

INSECTIVORA Shrews

Masked Shrew *Sorex cinereus*

The masked shrew occurs across northern North America from low arctic tundra south to the central Rocky Mountains and southern Appalachians in the United States. It occurs throughout the Delta Region, but is more common in the forest than on the tundra.

Dusky Shrew *Sorex obscurus*

The dusky shrew occurs in western North America from northern Mexico to Alaska. This species is rare in the Delta Region and has been reported only from Tuktoyaktuk.

Tundra Shrew *Sorex tundrensis*

The tundra shrew occurs only in Alaska and extreme northwestern Canada. It is found throughout the Delta Region and is more common in the forest than on the tundra.

LAGOMORPHA Pikas, Hares, and Rabbits

American Pika *Ochotona princeps*

The American pika is found in the mountains of western North America from New Mexico through Alaska. In the Delta Region scattered colonies occur in the Richardson Mountains. Colonies have been reported at Horn Lake, between Bear and Fish creeks about 48 km (30 mi) northeast of Horn Lake, and 21 km (13 mi) and 26 km (16 mi) northeast of Lapierre House. American pikas live only on rocky talus slopes where rocks are of sufficient size to allow construction of nests within the rock pile.

Snowshoe Hare *Lepus americanus*

The snowshoe, or varying hare, occurs in forests across North America as far south as the northern United States. Populations fluctuate widely in abundance over a ten-year cycle and in years of high numbers snowshoe hares are common in forested areas in the Delta Region. However, there are no long term records of population status of this species in the Delta Region.

Arctic Hare *Lepus arcticus*

The arctic hare occurs throughout the tundra of the Canadian Arctic and in the mountains of Newfoundland. In the Delta Region, this very large hare is uncommon on the Bathurst Peninsula and is probably absent from other tundra areas, although Porsild reported that it "occurs sparingly in the Caribou Hills and in the higher parts of the Eskimo Lake country". One was recorded from Fort Anderson and one was collected at Kittigazuit in December 1931.

RODENTIA Rodents

Hoary Marmot *Marmota caligata*

The hoary marmot occurs in the mountains of western North America from Alaska to Washington and Idaho. Porsild stated that "Indian hunters in the Mackenzie Delta assured me that the hoary marmot was found in the mountains west of the delta, and my brother, Mr. R.T.

Porsild, on May 8, 1927, reported seeing hoary marmots on Black Mountain southwest of Aklavik." However, no subsequent sightings have been recorded and no specimens have been taken; the occurrence of this species in the Delta Region remains unconfirmed.

Arctic Ground Squirrel *Spermophilus parryii*

The arctic ground squirrel occurs on arctic and alpine tundra and in forest clearings from northeastern Siberia, through Alaska, to Hudson Bay. In the Delta Region, this large ground squirrel is common on the tundra and is restricted to open areas in the forest where soils are well drained. Arctic ground squirrel colonies are usually found in sandy or gravelly soil on steep slopes or ridgetops and along the banks of the Mackenzie River.

Red Squirrel *Tamiasciurus hudsonicus*

The red squirrel occurs in forests in Alaska and Canada, in the northeastern United States and throughout parts of the Rocky Mountains as far south as the Mexican Border. It is associated with coniferous forests and especially with stands of white spruce, and is found throughout the forested area of the Delta Region. Populations vary in abundance between years.

Northern Flying Squirrel *Glaucomys sabrinus*

The northern flying squirrel occurs in forests across Canada, in the northern United States, in the mountains of the western United States, and in the Appalachians. There have been no confirmed records of the occurrence of this species in the Delta Region, but Preble referred to one taken at Fort Anderson.

Beaver *Castor canadensis*

The beaver occurs throughout North America from near tree line south to northern Mexico. In the Delta Region this species is most common near the Mackenzie River and in the Mackenzie Delta, but also occurs in other forested areas. It has been recorded in tundra areas east of the Mackenzie Delta and in the Anderson River delta. A detailed account of beaver in the Delta region is given on page 44.

Deer Mouse *Peromyscus maniculatus*

The deer mouse occurs throughout North America from northwestern Mackenzie District and Ungava south to southern Mexico. This species is accidental or rare in the Delta Region. Anderson reported that an adult male was taken at Herschel Island 6 August 1914 from a

Hudson Bay Company scow which came from Fort McPherson. The deer mouse is found at Fort Good Hope and may occur in other southern parts of the Delta Region.

Northern Red-backed Vole *Clethrionomys rutilus*

The northern red-backed vole occurs throughout much of the Soviet Union, in parts of Fennoscandinavia and in the northern boreal forest of North America west of Hudson Bay. Populations fluctuate widely in abundance. This species is found throughout the Delta Region, and is the dominant small mammal in most forest and shrub tundra areas. This species has been studied in the Delta Region by Manning and by Martell.

Brown Lemming *Lemmus sibiricus*

The brown lemming occurs throughout the low and mid-arctic tundra across the Soviet Union and North America, and in forests and alpine tundra in northwestern North America. Populations fluctuate widely in abundance. This species is found throughout the forests and tundra of the Delta Region.

Northern Bog Lemming *Synaptomys borealis*

The northern bog lemming is found in coniferous forests across northern North America. In the Delta Region, this species has been reported near Inuviik, where four specimens were collected, and near Summit Lake and Lapierre House. It is probably rare throughout most of the forested areas of the region.

Collared Lemming *Dicrostonyx torquatus*

The collared lemming occurs throughout the Arctic tundra of the Soviet Union, Fennoscandinavia, Alaska, Canada (excluding the mainland east of Hudson Bay), and northeast Greenland. Populations fluctuate widely in abundance. This species is found throughout the tundra of the Delta Region.

Muskrat *Ondatra zibethicus*

The muskrat occurs throughout North America from near tree line to the southern United States. Populations fluctuate widely in abundance. This species is found in lakes throughout the forested areas of the Delta Region and on tundra, particularly near the Mackenzie and Anderson river deltas. A detailed account of muskrat in the Delta Region is given on page 46.

Singing Vole *Microtus miurus*

The singing vole is found only in the mountains of Alaska, the Yukon, and extreme western Mackenzie District. This species has not been recorded in the Delta Region; however, it has been recorded from the Firth River drainage and the British Mountains and may extend into the Region in alpine tundra.

Meadow Vole *Microtus pennsylvanicus*

The meadow vole occurs throughout North America from near tree line south to central and southeastern United States. Populations fluctuate in abundance. In the Delta Region this species is found along the Mackenzie and Anderson river valleys and probably throughout most of the forests between. It also occurs in the vicinity of Lapierre House, and on tundra east of the Mackenzie Delta and near tree line west of Franklin Bay.

Tundra Vole *Microtus oeconomus*

The tundra vole is found throughout northern Eurasia and northwestern North America. Populations fluctuate in abundance. This species is found in moist tundra sedge meadows, often near lakes, both west and east of the Mackenzie Delta. Specimens have also been collected within tree line from Aklavik and Fort Anderson, and along the Bell River.

Long-tailed Vole *Microtus longicaudus*

The long-tailed vole is found throughout the mountains of western North America from the northern Yukon Territory south to Arizona and New Mexico. Populations fluctuate in abundance. In the Delta Region, this species has been recorded only from the vicinity of Horn Lake, in the Rat Pass and along the Bell River, but probably occurs at other locations in the Richardson Mountains.

Yellow-cheeked Vole *Microtus xanthognathus*

The yellow-cheeked vole occurs locally throughout interior northwestern North America. Populations fluctuate in abundance. This species occurs in isolated colonies in the Delta Region. In the last century it was recorded from Lapierre House, Fort McPherson, Fort Anderson, Anderson River and the Arctic coast at Franklin Bay. Recently colonies have been found south and east of Arctic Red River and in the Anderson River valley. It appears that these voles may have been more abundant fifty to one hundred years ago than at present.

House Mouse *Mus musculus*

The house mouse is native to central Asia, but presently occurs worldwide associated with man. The only record of this species in the Delta Region is that of two specimens taken in 1931 at a camp on the lower East Branch of the Mackenzie River.

Porcupine *Erethizon dorsatum*

The porcupine is found throughout North America from tree line south to northern Mexico and east-central United States. This species is very rare in the forests of the Delta Region, but has been recorded along the lower Peel River, in the Mackenzie Delta, along the upper Kugaluk River, and along the Anderson River. Porcupine occasionally wander onto tundra and there is a report that one was killed at Shingle Point.

CETACEA Whales and Porpoises

White Whale *Delphinapterus leucas*

The white whale, or beluga, occurs in northern circumpolar waters and in the Sea of Okhotsk, Bering Sea, and Baltic Sea. A relict population is found on the east coast of Canada in the Bay of Fundy and St. Lawrence estuary. This species is a regular summer migrant to the Delta Region. A detailed account of beluga in the Delta Region is given on page 17.

Narwhal *Monodon monoceros*

The narwhal occurs in Arctic waters from the central Canadian Arctic east to the Kara Sea. There have also been repeated, although rare, reports of narwhal off northern Alaska from Point Barrow to Demarcation Point. The occurrence of this species in the Delta Region is presently unconfirmed, although narwhal may have ranged into the Region in the 19th century. Richardson reported that people living at Toker Point in 1826 told him that narwhal, beluga, and bowhead were all found along the coast. Richardson also noted that these people had articles made of narwhal tusk. In early September 1850, the *Investigator* rounded Cape Bathurst; of the people on the ship who left accounts, two reported seeing narwhal, but two others did not.

Killer Whale *Orcinus orca*

The killer whale is found throughout the north Atlantic and Pacific Oceans, and, in Arctic waters, in the Chuckchi and Beaufort seas and from Baffin Bay east to the Barents Sea. This species is a rare summer visitor to the Delta Region. Two or three whales were seen in

Liverpool Bay in 1962 and there have been other reports of killer whales sighted from Herschel Island to Baillie Island.

Harbour Porpoise *Phocoena phocoena*

The harbour porpoise occurs along the coasts of the Pacific Ocean from Japan and Baja California north to the Chuckchi Sea, and along the coasts of the North Atlantic Ocean from New Jersey north to Greenland, Iceland, and the White Sea. Harbour porpoises have been reported occasionally off northern Alaska east to the Point Barrow area. A harbour porpoise was collected from near Shallow Bay in the Mackenzie Delta in 1973.

Gray Whale *Eschrichtius robustus*

The gray whale is found in the coasts of the Pacific Ocean from Baja, California and Korea, where they winter, northward to the Bering and Chuckchi seas and the Sea of Okhotsk, where they summer. Gray whales have been reported occasionally on the north coast of Alaska east to Barter Island. Three sightings of gray whales were made northwest of Cape Bathurst on 21-29 August 1980. There are no specific records of gray whales in the eastern Beaufort Sea in the logbooks of the whalers.

Bowhead Whale *Balaena mysticetus*

The bowhead whale occurs in Arctic waters in the Chuckchi and Beaufort seas and from the Canadian Eastern Arctic east to the Barents Sea, and southward to the Bering Sea and Gulf of St. Lawrence. This species is a regular summer migrant to the Delta Region. A detailed account of bowhead in the Delta Region is given on page 22.

CARNIVORA Dogs, Bears, Weasels, and Cats

Coyote *Canis latrans*

The coyote occurs throughout most of North America from near tree line south to Central America, excluding southeastern United States and northeastern Canada. This species is a very rare visitor to the Delta Region. Porsild reported that "at least for some years preceding 1927, coyotes have been invading the Mackenzie Delta, apparently from the west . . ." A coyote was taken on the Arctic coast east of the Mackenzie Delta in 1927, and another was shot by reindeer herders at Parsons Lake in 1974, and the skull was preserved for examination.

Wolf *Canis lupus*

The wolf formerly occurred throughout most of North America and Eurasia but has been exterminated in much of its former range. Wolves are fairly common residents or migrants in the Delta Region and are found in association with caribou, reindeer, Dall sheep and moose. There have been no systematic studies of wolves in the Delta Region, although during the course of other surveys some observations have been recorded.

Arctic Fox *Alopex lagopus*

The arctic fox occurs in northern circumpolar regions. It is found throughout the tundra and forest-tundra of the Delta Region, particularly near the coast. A detailed account of this species in the Delta Region is given on page 35.

Red Fox *Vulpes vulpes*

The red fox is found throughout most of North America and Eurasia and in northern Africa. This species is common throughout the forests of the Delta Region and is generally uncommon on shrub tundra. Red foxes show three distinct colour phases: red, cross, and silver. Red phase foxes are reddish with black ears and legs, cross phase are reddish or greyish brown with black guard hairs forming a cross on the shoulders, and silver phase are totally black except for white tips on the ears and tail and some white tipped guard hairs. All three colour phases are found in the Delta Region although silver foxes are rare. Red fox pelts traded at Fort Anderson in 1861 and 1862 consisted of 45% red phase, 42% cross phase, and 13% silver phase. Red foxes have been found on the tundra in the Delta Region at least since the 1860's.

Red fox and arctic fox denning ranges overlap somewhat on the tundra. However, red foxes tend to den in areas with dense shrub cover which are not used by arctic foxes. Red foxes on Richards Island have been found to den in sandy or sandy-loam soil on gentle to moderate (0-60%), well-drained slopes with southern exposures, less than 183 m (200 yds) from water. Denning red foxes on Richards Island feed primarily on ptarmigan and ducks, but may feed extensively on berries in late summer.

Black Bear *Ursus americanus*

The black bear occurs throughout most forested regions of North America from near tree line south to northern Mexico. This species is generally uncommon in the closed forests of the Delta Region, and is rare north of tree line. However, farther east in some areas the black

bear appears to be extending its range onto tundra, perhaps in response to a decline in numbers of barren-ground grizzly bears. This extension might also be expected in the Delta Region if the barren-ground grizzly population were to decline.

Grizzly Bear *Ursus arctos*

The grizzly bear formerly occurred throughout most of western North America, Eurasia, and northern Africa. In Canada its range is now confined to the Rocky Mountains, to the Swan Hills in Alberta, and to the tundra west of Hudson Bay. This species is common in the mountains and tundra of the Delta Region. Grizzly bears form many isolated or semi-isolated populations, each with its own distinctive characteristics. In the Delta Region one group is found in the Richardson Mountains and another in tundra areas. The latter group is the barren-ground grizzly, which tends to be lighter in colour than grizzly bears in other regions.

Grizzly bear habitat has been surveyed in the Delta Region and the best range is found on the Yukon North Slope and in the Richardson Mountains. It is estimated that the population density may be 1 bear/52 km^2 (1/20 mi^2) in the Richardson Mountains, slightly less on the North Slope, and 1 bear/200 km^2 (1/77 mi^2) in the southern Eskimo Lakes area.

In the northern Yukon the average litter size is 1.53 cubs per female which is similar to that for populations in northeastern Alaska and southwestern Yukon, but much lower than the 2.2-2.4 reported for populations in more southerly areas. Surveys suggest that mortality of cubs is relatively high.

Grizzly bears normally den from mid-October to early May, but may enter dens as late as November and emerge as early as April. On Richards Island, bears tend to den in sandy or sandy-clay soils on the banks of lakes or the lower portion of steep slopes of hills or pingos. Most dens are in areas of thick shrub cover and may be used for several years. Snow dens are occasionally dug and may be used in late winter or early spring after bears emerge from the winter den. After first leaving the den, bears may spend one or two weeks in the area, making day beds on sunny slopes and using the winter den at other times.

In the northern Yukon, many bears appear to move in April and May from dens in the mountains to the Yukon coast, and return to the mountains in September. On Richards Island, bears are in lowland areas in June and July where new vegetation and waterfowl are available, and in August they use upland areas where ripe berries and ground squirrels are found. A similar pattern of seasonal movement is found in the southern Eskimo Lakes area.

Polar Bear *Ursus maritimus*

The polar bear occurs in northern circumpolar regions. In the Delta Region, this species is most common on the ice along offshore leads, although it is seen near or on the coasts, primarily near Herschel Island and the tips of Tuktoyaktuk and Bathurst peninsulas. Polar bears have been reported as far inland as Fort McPherson and Old Crow, but inland movements of such distance are rare. A detailed account of this species is given on page 32.

Marten *Martes americana*

The marten formerly occurred in coniferous forests across northern North America and throughout the Rocky Mountains, however, it has been extirpated from much of the southern portion of its range. Marten are found in the forests of the Delta Region and they occasionally range beyond tree line as far as the coast. They are most common in the foothills west of Fort McPherson and in the vicinity of the forks of the Anderson River. Populations fluctuate widely in abundance, probably cyclically.

Ermine *Mustela erminea*

The ermine is found throughout northern North America and Eurasia. This species is generally common throughout the forests and tundra in the Delta Region but populations fluctuate in abundance and in some years ermine may be scarce.

Least Weasel *Mustela nivalis*

The least weasel occurs throughout northern North America and Eurasia. This species is rare in the Delta Region, but probably occurs throughout forest and tundra.

Mink *Mustela vison*

The mink occurs throughout most of North America from near tree line to the southern United States. This species is relatively common in the vicinity of lakes and rivers throughout the forests of the Delta Region and is occasionally found along rivers on the tundra as far north as the Arctic coast. Populations in the Mackenzie Delta fluctuate widely in abundance. In winter, mink are seldom seen because they live under the shoreline ice ledge which forms as the water level recedes after freezeup. In summer, mink in the Delta Region feed almost entirely on small mammals and snowshoe hare.

Wolverine *Gulo gulo*

The wolverine formerly occurred throughout most of northern North America and Eurasia, but has been extirpated from much of the southern portion of its range. This species is found throughout the forests of the Delta Region year round and on the tundra in winter. It is generally uncommon, but has been observed most frequently in the Richardson Mountains and on the Yukon North Slope and along the coast of Franklin Bay in winter.

River Otter *Lutra canadensis*

The river otter occurs throughout most of North America from near tree line to the southern United States. This species is very rare in the Delta Region. It has been reported from the Fort McPherson area, the Mackenzie Delta, Anderson River, and the headwaters of the Smoke River.

Lynx *Lynx lynx*

The lynx occurs throughout much of northern North America and Eurasia. This species is common in some years throughout the forests of the Delta Region, but populations fluctuate cyclically in abundance, following fluctuations of snowshoe hare populations. Lynx seldom venture far onto tundra. In the Delta Region they have been observed on the Tuktoyaktuk Peninsula south of Atkinson Point, in the Franklin Bay area, near Parsons Lake and on southern Richards Island.

PINNIPEDIA Seals, Sea Lions, and Walrus

Northern Sea Lion *Eumetopias jubata*

The northern sea lion is found along the coasts of the North Pacific Ocean from Japan and California north to the Bering Strait. This species has only been recorded once from Herschel Island and there are no other records of its occurrence in the Delta Region.

Northern Fur Seal *Callorhinus ursinus*

The northern fur seal is found along the coasts of the North Pacific Ocean from Japan and California north to the Bering Strait. This species occurs very rarely in the Delta Region. One was taken near Shoalwater Bay in 1951 and one was reported taken at Herschel Island in 1940 or 1941. One was also taken at Letty Harbour, just east of the Delta Region, in 1958.

Walrus *Odobenus rosmarus*

The walrus occurs in northern circumpolar waters and in the Bering Sea. Formerly its range extended to Kamchatka, southern Alaska, and the coast of New England. This species is presently a regular, although rare, summer visitor to the Delta Region. MacFarlane reported that in the 1860's walrus were numerous between Point Barrow and Cape Bathurst and he observed a few at the southern end of Franklin Bay between 1862 and 1865. He also observed that Anderson River Inuit used umiaks made of walrus hides and that they had many articles made of walrus ivory. However, there are no records of walrus from earlier expeditions (1826–1850) and Franklin and Petitot reported that some Inuit near the Mackenzie Delta did not know the walrus. It is likely that walrus were not as generally numerous as MacFarlane suggested, but there may have been a small population in Franklin Bay and possibly in Liverpool Bay. There are several records of walrus at Herschel Island or along the Yukon coast and from the Baillie Island–Franklin Bay area.

Bearded Seal *Erignathus barbatus*

The bearded seal occurs in northern circumpolar waters and in the Bering Sea and Sea of Okhotsk. It is common in the Delta Region and a detailed account of this species is given on page 30.

Harbour Seal *Phoca vitulina*

The harbour seal is widespread in the northern hemisphere; it is found along the coasts of the Pacific Ocean from Korea and California north to the Bering Strait, in the Chukchi and Beaufort seas, along the coasts of the Atlantic Ocean from New England and Spain north to Greenland and Scandinavia, and in the Canadian Eastern Arctic and the Barents Sea. This species is rare in the Delta Region although several animals were taken at Herschel Island in 1926 and 1973. Some animals seen in the channels of northwestern Richards Island in 1972 were tentatively identified as harbour seals.

Ringed Seal *Phoca hispida*

The ringed seal occurs in northern circumpolar waters; in the Bering Sea, Sea of Okhotsk, and Baltic Sea; and in the coastal waters of the northwest Atlantic Ocean south to Newfoundland. This species is common in the Delta Region and a detailed account is given on page 28.

Harp Seal *Phoca groenlandica*

The harp seal is found in northern waters from the Canadian Eastern Arctic and Gulf of St. Lawrence east to the Kara and Barents seas. The only record of this species in the Delta Region is of one caught in a fishnet at Aklavik in 1924 or 1926.

Hooded Seal *Cystophora cristata*

The hooded seal is found in northern waters from the Canadian Eastern Arctic and Gulf of St. Lawrence east to Spitsbergen and Novaya Zemlya. This species has only been recorded twice in the Delta Region: at Herschel Island in 1931 and at Tuktoyaktuk in 1941-42.

ARTIODACTYLA Cloven-hoofed Mammals

Woodland Caribou *Rangifer tarandus caribou*

The woodland caribou is a large, dark subspecies of caribou which occurs in the Canadian boreal forest from British Columbia and Alberta east to Labrador and Newfoundland. In the Delta Region the distribution of woodland caribou is not well known, but they appear to range principally in the forests of the southeastern part of the Region.

Grant Caribou *Rangifer tarandus granti*

The Grant caribou is a dark subspecies, intermediate in size between woodland and barren-ground caribou, that occurs throughout Alaska and western Yukon Territory. In the Delta Region this subspecies is found west of the Mackenzie River. A detailed account of Grant caribou in the Delta Region is given on page 38.

Barren-ground Caribou *Rangifer tarandus groenlandicus*

The barren-ground caribou is a medium-size subspecies that occurs on Canadian mainland tundra and forest-tundra from near the Mackenzie Delta east to Hudson Bay, and on Southhampton, Coats, and Baffin islands. In the Delta Region this subspecies is found east of the Mackenzie River. A detailed account of barren-ground caribou in the Delta Region is given on page 41.

Peary Caribou *Rangifer tarandus pearyi*

The Peary caribou is a small, pale subspecies found throughout the Canadian Arctic Archipelago (exclusive of Baffin Island) and in northwest Greenland. This subspecies has been

observed only rarely in the Delta Region. A group of thirty to forty apparently crossed from Banks Island in November 1951 and were seen at Nuvorak Point, Harrowby Bay, and Baillie Island; one was shot on the mainland near Herschel Island. In the winter of 1963-64, one Peary caribou wandered as far south as the vicinity of Old Crow.

European Reindeer *Rangifer tarandus tarandus*

The European reindeer is a medium-size subspecies found across Eurasia that has been introduced into Alaska and Canada. A herd was brought into the Delta Region in 1935 after a five-year journey from Alaska. Although most of the herd is semi-domesticated and is held under private ownership, feral groups occur in the Region, and one herd is found year round on Richards Island. The subspecies is discussed in relation to native subspecies on page 38

Moose *Alces alces*

The moose occurs in northern forests in Eurasia, and in Alaska and Canada south to the northeastern United States and parts of the southern Rocky Mountains. It is occasionally found north of tree line, generally along river valleys. There have been no systematic studies of moose in the Delta Region. Moose are common in parts of the forested area of the Region and have been observed north of tree line on the Mackenzie Delta, Richards Island, the Anderson River Delta and the Bathurst Peninsula north to Baillie Island. Moose have also been observed on the North Slope in summer and limited data indicate that they move south of tree line to overwinter. Much of the Region has been classed as poor moose habitat.

Mountain Goat *Oreamnos americanus*

The mountain goat occurs only in the mountains of western North America from southeastern Alaska and southern Yukon Territory south to Oregon and Idaho. The occurrence of this species has not been confirmed in the Delta Region. MacFarlane reported that in the 1860's mountain goats were found in the mountains west of the Mackenzie River north at least to the Arctic Circle. Isbister reported seeing some on the Rat River in 1841, Ross noted that three were taken at Lapierre House in 1860-61, and Ogilvie reported that mountain goat were numerous around Rat Pass in 1889. Although it is possible that these authors were mistaking Dall sheep for mountain goat, MacFarlane, Isbister and Ogilvie also referred to sheep in their accounts and Ross reported on both species.

Muskox *Ovibos moschatus*

The muskox formerly occurred in the Canadian Arctic Archipelago (exclusive of Baffin Island), in northeast Greenland, and on low arctic tundra to below tree line from Alaska to Hudson Bay. It has since been extirpated from the eastern, western and southern parts of its mainland range. This species occurred in the eastern part of the Delta Region in the last century, but the last individuals were probably taken by whalers around the turn of the century. MacFarlane noted that in the 1860's muskoxen were uncommon between the Mackenzie and Anderson rivers, but were common east of the Anderson River; he saw several between Fort Anderson and Franklin Bay including one herd of twenty-five individuals of various ages. He noted that these muskoxen wintered up to 64-80 km (40-50 mi) and occasionally up to 161 km (100 mi) south of tree line and migrated northward to the tundra in spring.

Originally, muskoxen were probably little hunted by the inhabitants of the Region, but after the establishment of Hudson Bay Company posts many hides were brought in for trade. By about 1890, muskoxen had been extirpated west of the Anderson River. In the late 1890's whalers began wintering at Langton Bay and Baillie Island and Anderson noted that over eighty animals were killed in one winter. Bodfish, a whaling captain who wintered at Langton Bay in 1897-98 and at Baillie Island in 1898-99 and in 1900-01, noted that: "While we wintered in the Arctic they (Inuit hunters with the whaling ships) killed all the muskoxen in an area of 150 miles."

Hunting of muskoxen was banned in Canada in 1917 and, in response to protection, mainland populations have increased and are reoccupying parts of their former range. In the Delta Region they now occur east of Horton River. Following reintroduction of muskoxen to northern Alaska some muskoxen were observed in 1969-1970 in the vicinity of Herschel Island and as far east as Moose Channel. In northern Yukon observations of single animals have been recorded in most years since 1970, and in 1973 one group of six animals was seen on the Spring River, southeast of Herschel Island.

Dall Sheep *Ovis dalli*

Dall sheep occur only in the mountains of northwestern North America, from Alaska and the Yukon east into the western Mackenzie District and south into northern British Columbia. In the Delta Region this species occurs in the Richardson Mountains southwest of Aklavik. Surveys of sheep in the Mount Goodenough area and along the proposed pipeline route in the Richardson Mountains have been made in recent years, but there have been no systematic studies of this

species in the Delta Region. Habitat surveys have been made in the Richardson Mountains and the area between Mount Goodenough west to the divide between the Mackenzie-Yukon watersheds is classed as the best Dall sheep habitat in the Region.

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4. BIRDS OF THE MACKENZIE DELTA REGION

4.1 Introduction

Very few species of birds are adapted to overwinter in the Delta Region. The vast majority migrate into or through the Region to nest, raise young, moult and accumulate fat reserves, before migrating south in the fall to overwinter in other regions. Of 137 species recorded from the Delta Region, 17 are resident year round, 101 nest and/or moult and remain during the summer and 19 are rare transients or visitors. In addition, a further 39 species have been reported, but their occurrence has not been confirmed.

Recognition of international obligations in management of migratory birds resulted in the passage of the Migratory Birds Convention Act in 1916. Information from aerial surveys of numbers, distribution and breeding success of waterfowl was, therefore, acquired over successive years, in addition to information from some ground based studies. Other data have been acquired from impact oriented studies related to proposed industrial or public works developments, principally the Mackenzie Valley Pipeline and offshore drilling in the Beaufort Sea. There have been no long term integrated studies in the Region of birds as components of ecosystems.

Two groups of birds, waterfowl, which are migratory, and ptarmigan, which are resident, are discussed in some detail. Distribution of all species of birds that have been reported from the Region is outlined in an annotated species list. A comprehensive list of birds in the Mackenzie Delta and in the Eskimo Lakes area was compiled by Porsild in 1943, and a literature review of birds of the Beaufort Sea by Johnson *et al.* was published in 1975.

In this report, world distribution of species is based on references by Vaurie and by Godfrey; nomenclature conforms to that of the American Ornithologists' Union Check List.[5]

4.2 Waterfowl

Introduction

Waterfowl migrating into the Delta Region use staging areas in spring for resting and feeding, areas for nesting, feeding, rearing young and moulting during summer, and staging areas

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[5] The convention of using upper case letters has not been observed.

Figure 5. Major Areas in the Mackenzie Delta Used by Waterfowl

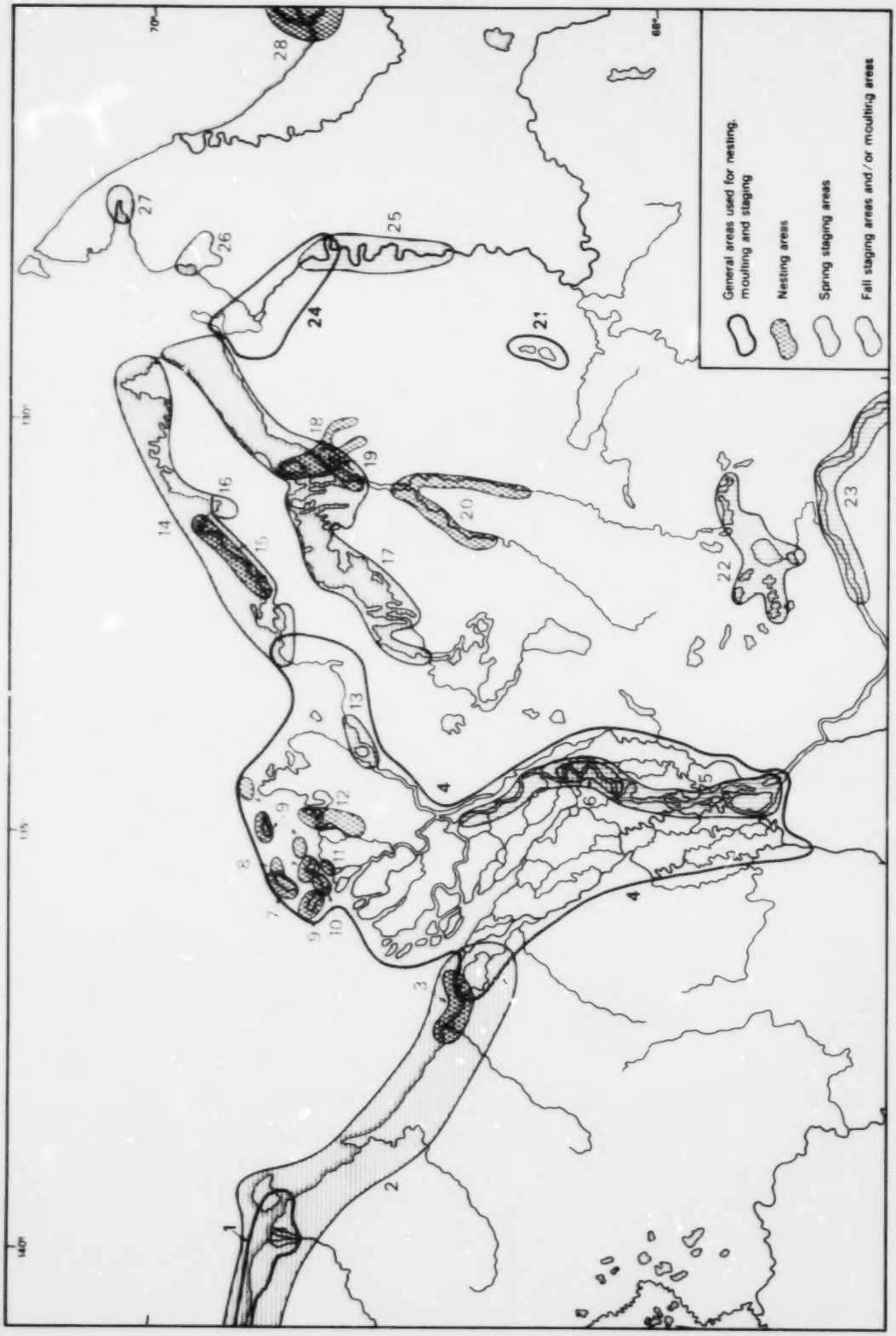

Table 4. Key to the Major Areas Used by Waterfowl shown in Figure 5. Information compiled principally from Canada Land Use Information Series and Arctic Ecology Series maps, and from Barry, 1976.

1. Important nesting, moulting and fall staging area for sea ducks. King and common eider nest on Herschel Island and along the coast. The Firth and Malcolm deltas are important spring staging areas for whistling swans.
2. Critical fall staging area for large numbers of waterfowl including snow geese, brant and white-fronted geese. Phillips Bay is a critical nesting and moulting area for whistling swans.
3. Critical nesting and moulting area for whistling swans and dabbling ducks, and fall staging area for snow geese, brant, and white-fronted geese.
4. Critical nesting, moulting and staging area for waterfowl. Ellice Island and Shallow Bay are important fall staging areas. Kendall Island Migratory Bird Sanctuary is a critical nesting area for snow geese, brant and whistling swans.
5. Spring staging area for large numbers of snow, white-fronted and Canada geese and whistling swans.
6. Moulting area for non-breeding whistling swans.
7. Critical nesting and moulting area for whistling swans.
8. Critical nesting area for brant.
9. Critical nesting area for waterfowl.
10. Critical nesting area for whistling swans.
11. Critical nesting area for snow geese, brant, white-fronted geese and whistling swans.
12. Critical nesting and moulting area for white-fronted geese and whistling swans.
13. Spring staging area for snow geese, white-fronted geese, whistling swans and ducks.
14. Important coastal moulting and fall staging area for sea ducks.
15. Critical nesting and moulting area for brant and white-fronted geese, and moulting area for oldsquaws and scoters.
16. Critical nesting and moulting area for whistling swans and moulting area for white-fronted geese, brant, oldsquaws, scaup and scoters.
17. Moulting and fall staging area for scoters and scaup.
18. Critical nesting and moulting area for large numbers of Canada geese, white-fronted geese, brant and whistling swans. The Smoke and Moose rivers are also critical moulting areas for oldsquaws, scaup, mergansers and scoters.
19. Critical staging area for waterfowl of unit 18.
20. Nesting and moulting area for white-fronted geese, Canada geese, whistling swans and ducks.
21. Nesting, moulting, and fall staging area for canvasbacks, scoters, scaup and whistling swans.

Table 4 continued

22. Spring staging area for whistling swans and moulting area for non-breeding swans

23. Spring staging area for snow geese, white-fronted geese, whistling swans, Canada geese and ducks.

24. Anderson River Migratory Bird Sanctuary is a critical nesting area for snow geese, brant, white-fronted geese, and whistling swans, and a critical moulting area for scaup, oldsquaws and scoters.

25. Spring staging area for whistling swans and white-fronted geese, and nesting area for Canada geese.

26. Mason River Delta is a critical moulting area for white-fronted geese and whistling swans. Mason River Valley is a moulting area for Canada geese, snow geese and ducks.

27. Harrowby Bay (Old Horton Channel) is a critical moulting area for Canada geese and white-fronted geese.

28. Critical moulting area for Canada geese and a nesting area for whistling swans, white-fronted geese and ducks.

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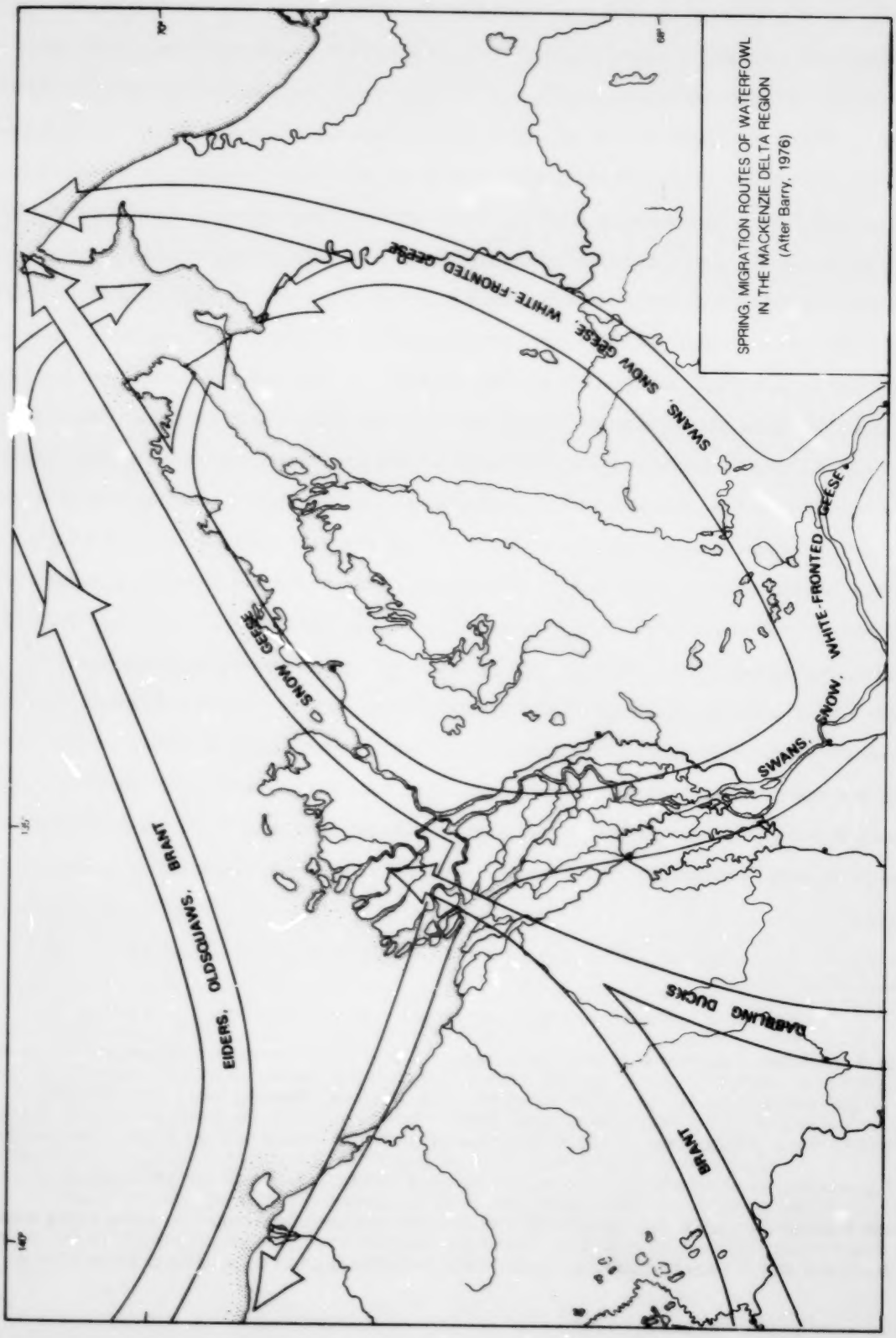
in late summer and fall for feeding before, or during, their migration south. Some species also breed in spring staging areas. Important staging, nesting and moulting areas in the Region are shown in Figure 5 and summarized in Table 4. Seventeen species of waterfowl (swans, geese and ducks), commonly nest in the Region and non-breeding groups of these species may congregate for moulting and feeding. In addition, large numbers of waterfowl that migrate through the Region use areas within the Region for staging. The Delta Region is therefore, one of the most productive places in the North for waterfowl and contains two migratory bird sanctuaries, Kendall Island and the Anderson River Delta.

Spring Migration

Many of the waterfowl that nest in, moult in, or migrate through the Delta Region overwinter in the south-central United States, along the Gulf Coast and in central California. Others winter along the Pacific coast from the Aleutian Islands to Baja California. Depending on the location of their overwintering areas, waterfowl may reach the Delta Region by inland or coastal migratory routes, and either disperse within the Region, or move west to Alaska, or east or northeast to Amundsen Gulf and Banks Island (Figure 6). Regardless of whether waterfowl

Figure 6. Spring Migration Routes of Waterfowl in the Mackenzie Delta Region



follow inland or coastal routes they are dependent on areas of open water for staging. In sea ice these are polynyas, which may be open most of the year, or leads that form early in the spring. Along inland routes in the North, areas of open water form before ice breakup along shallow shorelines of islands, sandbars, and in old meander channels and snyes, as well as at the outlets of some lakes and at the mouths of some streams and rivers. Along both coastal and inland routes, the time when areas of open water form and their extent vary from year to year. In 1964, there were no leads in the southeastern Beaufort Sea until late June and it was estimated that 100,000 eiders and other seabirds starved as a result. In 1974, leads were few and small and contained concentrations of thousands of waterbirds. A major system of leads in the Beaufort Sea occurs north and east of the Delta Region, however, leads which normally form off Herschel Island, Cape Dalhousie and Bathurst Island are also important to waterfowl.

In the Mackenzie River, open water in the vicinity of Little Chicago forms a major spring staging area in the Region for waterfowl from inland areas. In 1965, 130,000 snow and 15,000 white-fronted geese were counted near Little Chicago, and another 65,000 snow and 5,000 white-fronted geese were counted on the Anderson River. In 1972, there was a late spring and the peak of migration at Little Chicago occurred during the third week of May, while in 1973, it was at least a week earlier. Swans and geese reach nesting areas during the second or third week of May and most species of ducks arrive about a week later. The first geese to arrive are snow and white-fronted geese followed by brant and then Canada geese. Arrival of swans and geese is quite regular from year to year, indicating that day length is more important than local weather conditions in controlling time of migration, although the peak of migration can be delayed by poor weather. Arrival of ducks shows more variation between years than that of geese.

Nesting and Moulting

Despite the long migration, geese gain weight during the flight north and are usually in good condition when they reach the Delta Region. Depending on snow conditions in the nesting grounds, geese begin to nest within about ten days of arrival. Nesting may begin with only 5-10% of the ground clear of snow. The time of nesting is critical to the reproductive success of geese and other waterfowl. Geese that are unable to nest due to prolonged snow cover may resorb developing eggs and become part of the non-breeding population. In some years spring floods and storm tides may destroy many nests, particularly of birds such as brant and snow

geese that nest in low-lying areas. Barry reported that about 3% of the brant nests in the Anderson River Delta were destroyed by storm tides in 1959, 1962 and 1963. He also found that, in 1964, the late but rapid snowmelt caused floods which destroyed about 25% of the snow geese nests, and in late June a severe storm destroyed the remainder. About 75% of the nests of white-fronted geese and 50% of the brant nests were also destroyed. Birds that lose their clutches from adverse weather or predation cannot renest successfully.

Productivity may also be limited by predation of eggs and young birds. The principal avian predators of eggs and young are parasitic jaegers, glaucous gulls, golden eagles, snowy and short-eared owls and ravens. Predation by foxes can sometimes be extensive. Barry saw an Arctic fox remove all the eggs from 112 brant nests in four days; the fox ate about 5% of the eggs and cached the rest. Grizzly bears occasionally enter goose colonies and search for nests. Damage may then be extensive since the parent birds leave the nests unprotected, and eggs and nestlings that are not consumed by bears may be taken by avian predators. Human disturbance, such as that from helicopter flights, has also resulted in parent birds leaving nests, and subsequent predation. In some areas humans also take numbers of eggs in addition to a harvest of adult birds through hunting.

Whistling swans nest on the tundra in moist sedge meadows, near lakes and in low shrub. Individuals seen in forested areas are generally non-breeders, although nesting has been recorded. Brant nest at the outer edges of deltas and along the coast close to the sea. Snow geese nest inland from brant, white-fronted geese nest farther inland than snow geese, and Canada geese usually nest in forested areas. White-fronted and Canada geese space their nests more widely than brant and snow geese, and more accurate estimates can be made of the latter two species when nesting than of the former.

Both breeding and non-breeding birds form large flocks for moulting and feeding during summer. The flightless birds and broods of young are vulnerable during this period to predators and in coastal waters to storms, and concentrate in areas that offer protection and in which food is abundant. Sheltered estuarine and coastal waters, as well as barrier beaches and coastal lagoons, are used extensively by some species. Other species use upper deltas extensively and some inland waterbodies. Many sea ducks migrate to Alaskan waters for moulting.

Moulting is energetically expensive and birds require abundant food resources to accumulate sufficient fat reserves before migrating south. Young birds must grow very rapidly

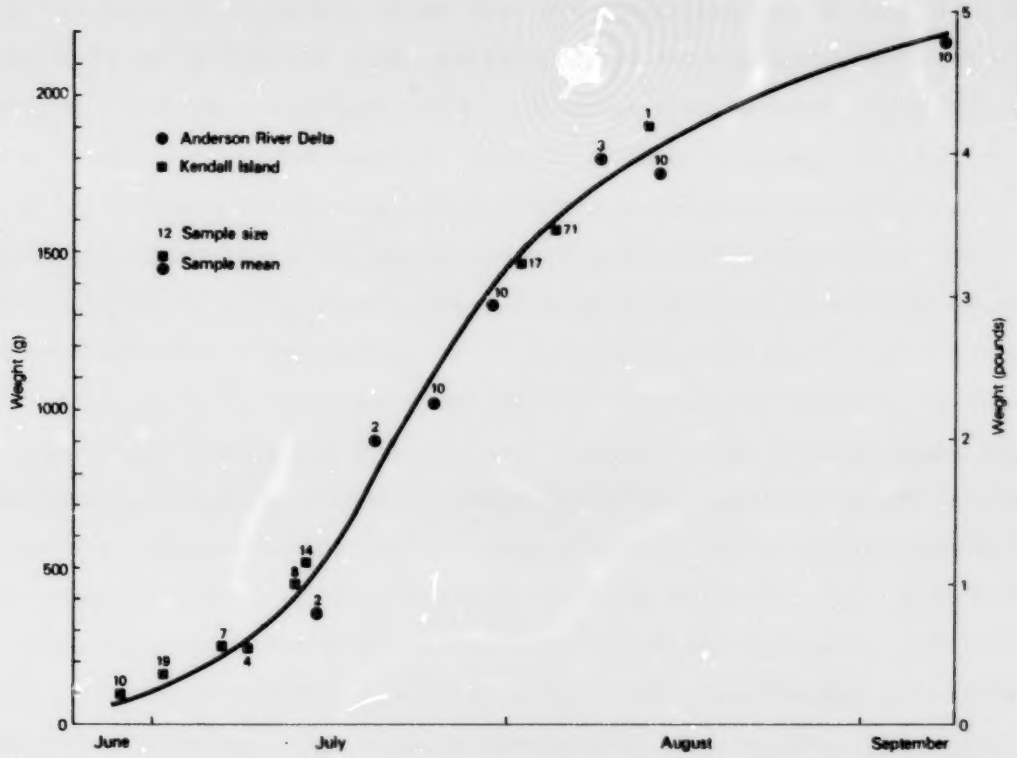


Figure 7. Growth Rate of Young Snow Geese in the Delta Region Based on Records from the Anderson River Delta (Barry, 1967) and Kendall Island (J.C. Holmes, unpublished data from 1958).

during the short summer to be able to migrate during the fall (Figure 7).

Fall Migration

From aerial surveys of the Mackenzie Delta, and the Yukon and Alaskan North Slopes, observed distribution and movements of waterfowl, and estimates of peak numbers or densities, have been found to vary among years. However, waterfowl generally begin to move to staging areas about mid-August in preparation for migration. Brant and sea ducks stage along the coast as they move west to Alaska and the Pacific Flyway. Other waterfowl that have nested in Alaska move east along the Yukon North Slope prior to migrating up the Mackenzie Valley. Some snow geese move to feeding areas on the Alaskan North Slope, or adjacent coast, and then return to the Mackenzie Valley in September before flying south. Generally the same routes that are used in spring migrations are used in fall migration out of the Region.

Table 5. Estimates of Total Numbers of Geese in Four Colonies in the Delta Region (Figure 9) by U.S. Fish and Wildlife Service 1948–54.

Year of Survey	Snow Geese	Brant Geese	White-fronted Geese	Canada Geese
1948	7,320	2,377	901	596
1949	2,943	2,510	825	567
1950	5,390	2,004	1,112	62
1951	7,360	1,294	120	-
1952	9,489	3,147	8	-
1953	8,580	1,303	174	-
1954	7,189	1,014	317	509

Numbers

Since 1948, aerial surveys of waterfowl in part of the Mackenzie Delta Region have been made each spring by the U.S. Fish and Wildlife Service. Estimates of total numbers of waterfowl have been calculated from observations of birds and the area flown. These estimates provide indices of changes in populations over a series of years since the same transects have been flown each year, and assumptions made in analysis of data were unchanged until 1974. In that year, changes were made in analysing and presenting data so that subsequent indices can not be compared with those of earlier years.

From 1948–54, five types of habitat were surveyed (Figure 8); subsequently only the wooded and treeless areas of the Mackenzie Delta and the upland tundra to the east were covered. Size and species composition of the four major goose nesting colonies in the Delta Region are shown in Figure 9 for 1948–54. Numbers of geese in these colonies have varied between years (Table 5). Numbers of geese estimated from various surveys made between 1955 and 1960 within the Mackenzie Delta and Liverpool Bay areas suggest a considerable increase in the number of snow, white-fronted and Canada geese, while brant populations appear to have remained stable since the 1948–54 period. However, for reasons stated above, these data may not be comparable with earlier data and conclusions are only tentative. Other

Figure 8. Approximate Zones in Which Waterfowl Counts Were Made by United States Fish and Wildlife Service and the 1948–54 Mean Density of Swans and Ducks.

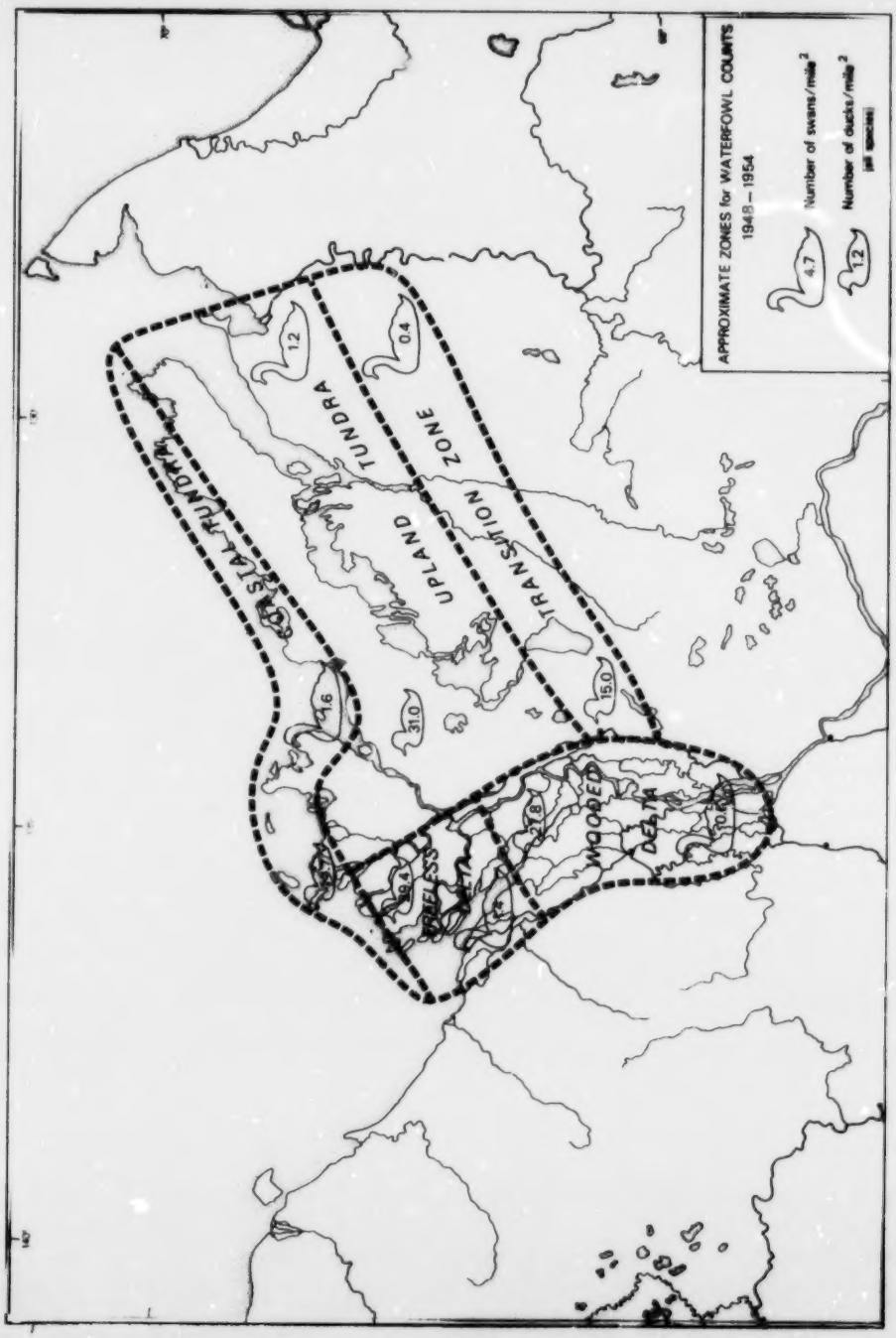
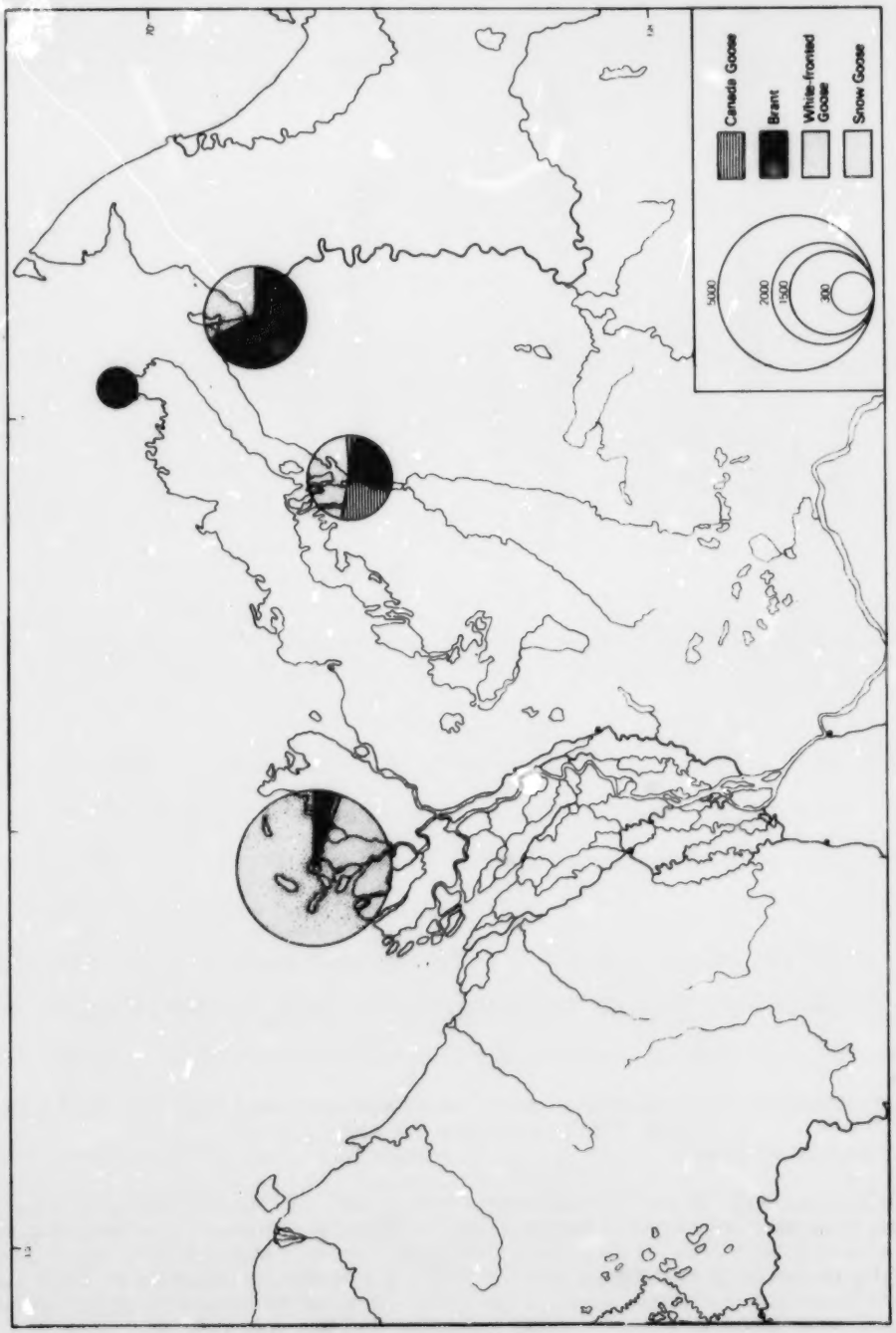


Figure 9. Size and Composition of Four Major Goose Nesting Colonies in the Delta Region, Based on U.S. Fish and Wildlife Service Surveys (size, 1948–54; composition, 1948–50).



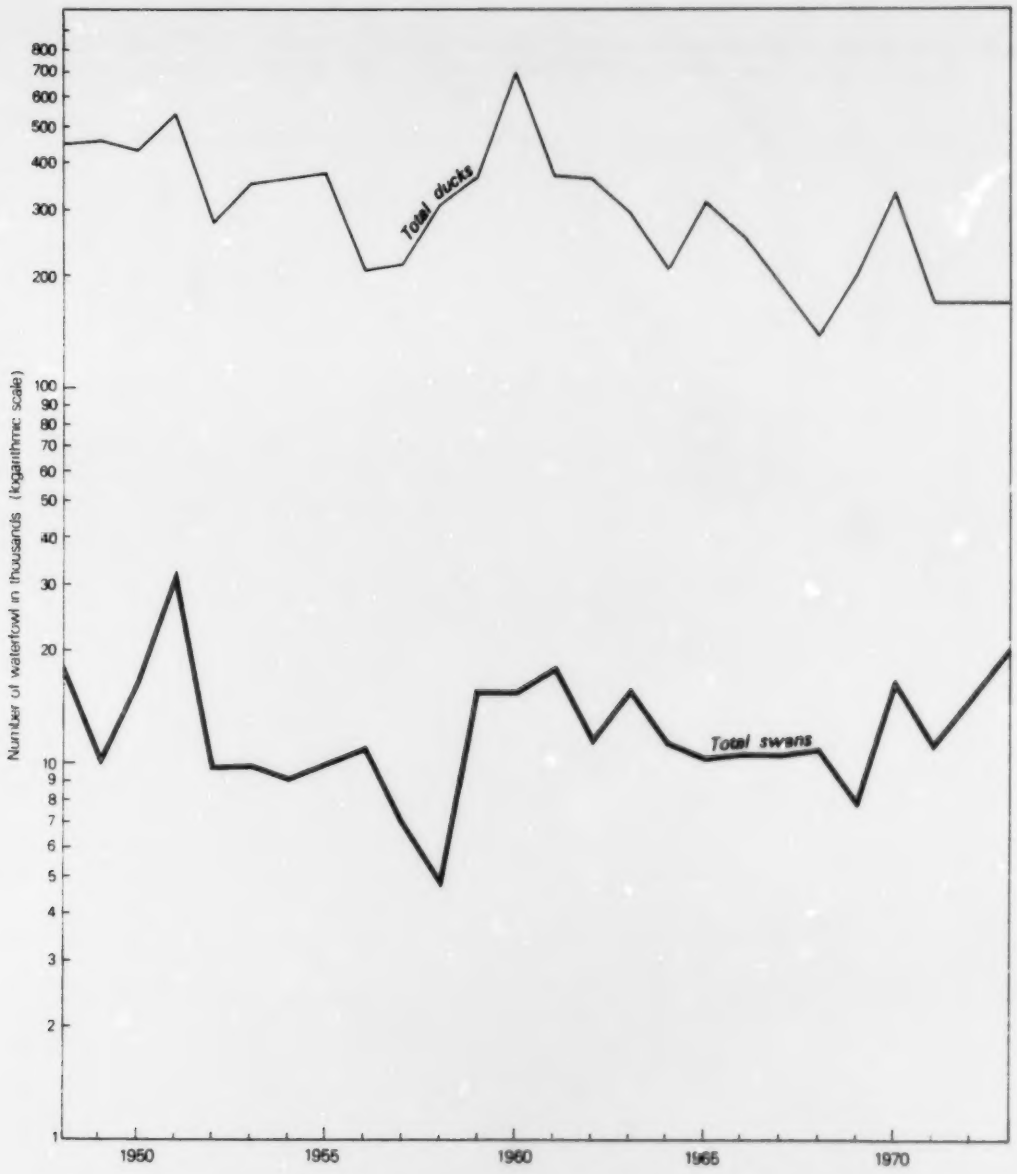


Figure 10. Total Mackenzie Delta and Upland Tundra Duck and Swan Index, 1948–73, Based on U.S. Fish and Wildlife Service Surveys.

colonies may have been important in the past. For example, a captain of a whaling ship reported collecting fifty dozen eggs near Baillie Island in 1901 and Anderson reported in 1913 that a few snow geese formerly nested at Baillie Island, indicating that this was a mixed colony.

Swan numbers in the survey area appear to have been relatively stable from 1948–73 (Figure 10).

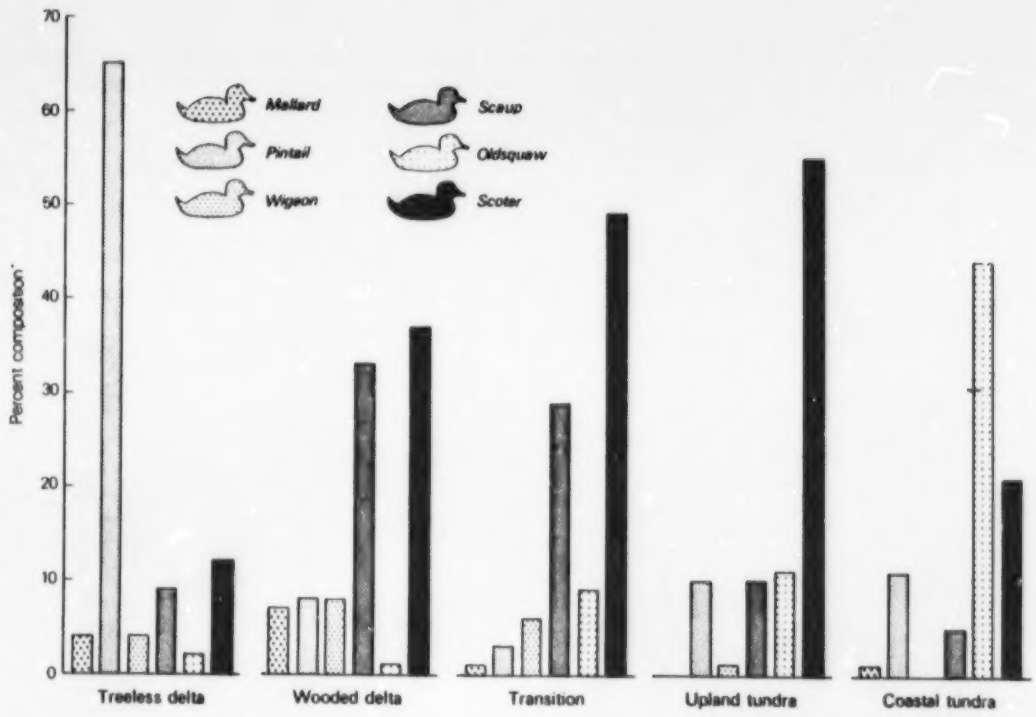


Figure 11. Proportions of the Dominant Duck Species Found in Five Habitat Zones of the Delta Region. (Based on U.S. Fish and Wildlife Service Surveys, 1948–54.)

Based on spring aerial surveys from 1948–54, the estimated total duck density was 11–12/km² (29–31/mi²) in the Treeless Delta and the Upland Tundra, and 6/km² (15/mi²) in the Transition Zone and the Coastal Tundra (Figure 8). Duck densities in the forested portion of the Delta averaged 11/km² (28/mi²) from 1948–54.

The composition of duck populations varies according to species' habitat preference (Figure 11). Pintail are the most common duck on the Treeless Delta, while scaup and scoter make up the majority of ducks found in the Wooded Delta and Transition Zone. Scoter predominate in the Upland Tundra and oldsquaw are most common in the Coastal Tundra.

The composition and relative abundance of duck populations have fluctuated considerably over the years (Figures 10 and 12). The peak in estimated numbers in 1960 coincided with a period of drought on the prairies. In dry years waterfowl that normally nest in prairie wetlands move farther north. These movements are reflected in higher waterfowl counts in the Delta Region. Cowan visited the Mackenzie Delta in 1947 and compared his waterfowl observations

Figure 12. Composition of Duck Populations in the Mackenzie Delta, 1948–73. Based on U.S. Fish and Wildlife Service Surveys. (In this 'layer cake' diagram the thickness of a band represents the size of that species' population.)

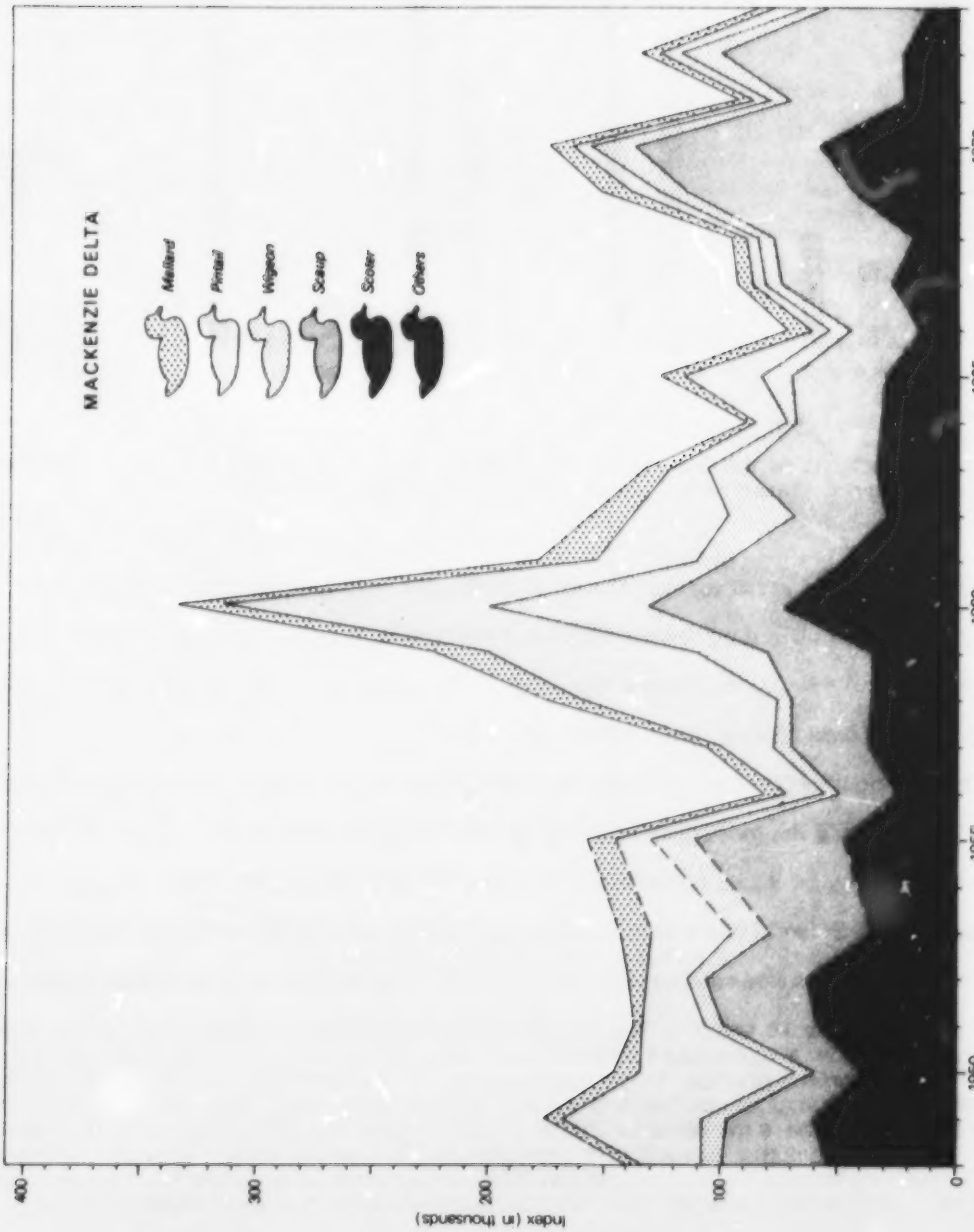
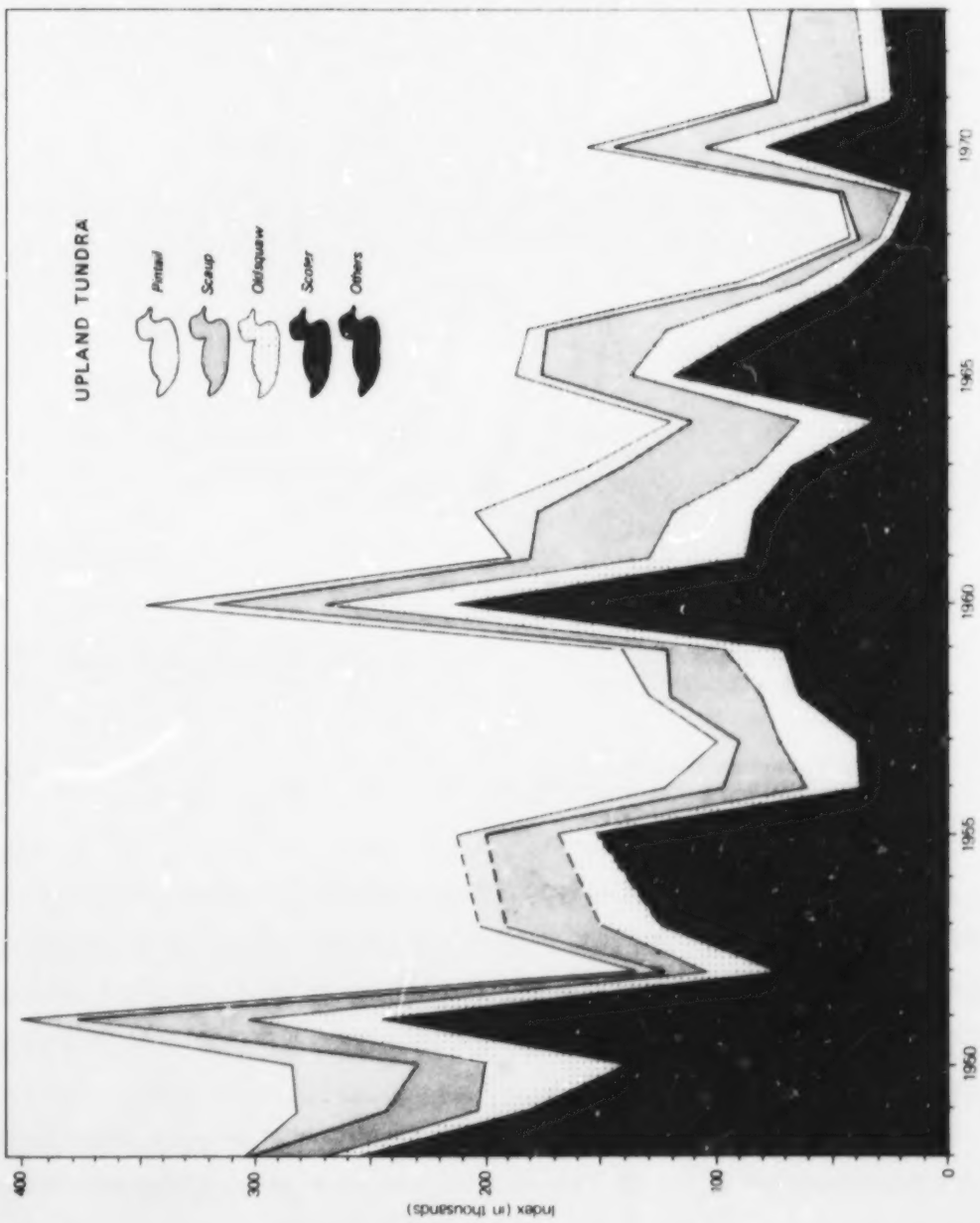


Figure 13. Composition of duck populations in the Upland Tundra, 1948–73, based on U.S. Fish and Wildlife Service surveys. (In this 'layer cake' diagram the thickness of a band represents the size of that species' population.)



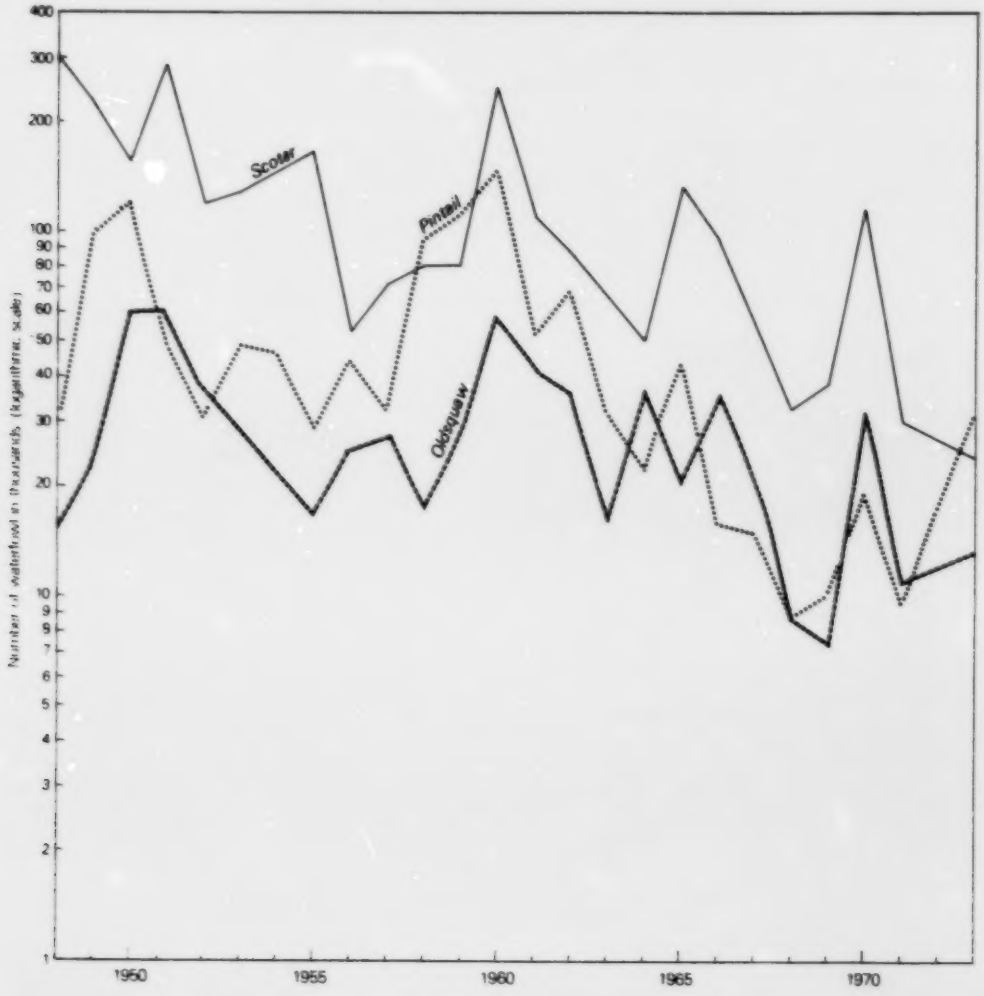


Figure 14. Total Mackenzie Delta and Upland Tundra Indices for Pintail, Scoter and Oldsquaw, 1948–73, Based on U.S. Fish and Wildlife Service Surveys.

with those of Porsild in 1934. Cowan reported a total decline in waterfowl populations of 91–97%, with the decline in wigeon and pintail approaching 99%. This apparent decline was probably due to large numbers of prairie waterfowl present in the Delta, in 1934, due to destruction of wetlands from dry farming practices and years of drought in some prairie regions during the 1930's.

From 1948–73 the total number of ducks in the Mackenzie Delta and Upland Tundra appears to have declined (Figure 10). Reductions in numbers of pintail, scoter and oldsquaw (Figure 14) have contributed to this decline, in contrast to fluctuations in numbers of mallard, wigeon and scaup (Figure 15).

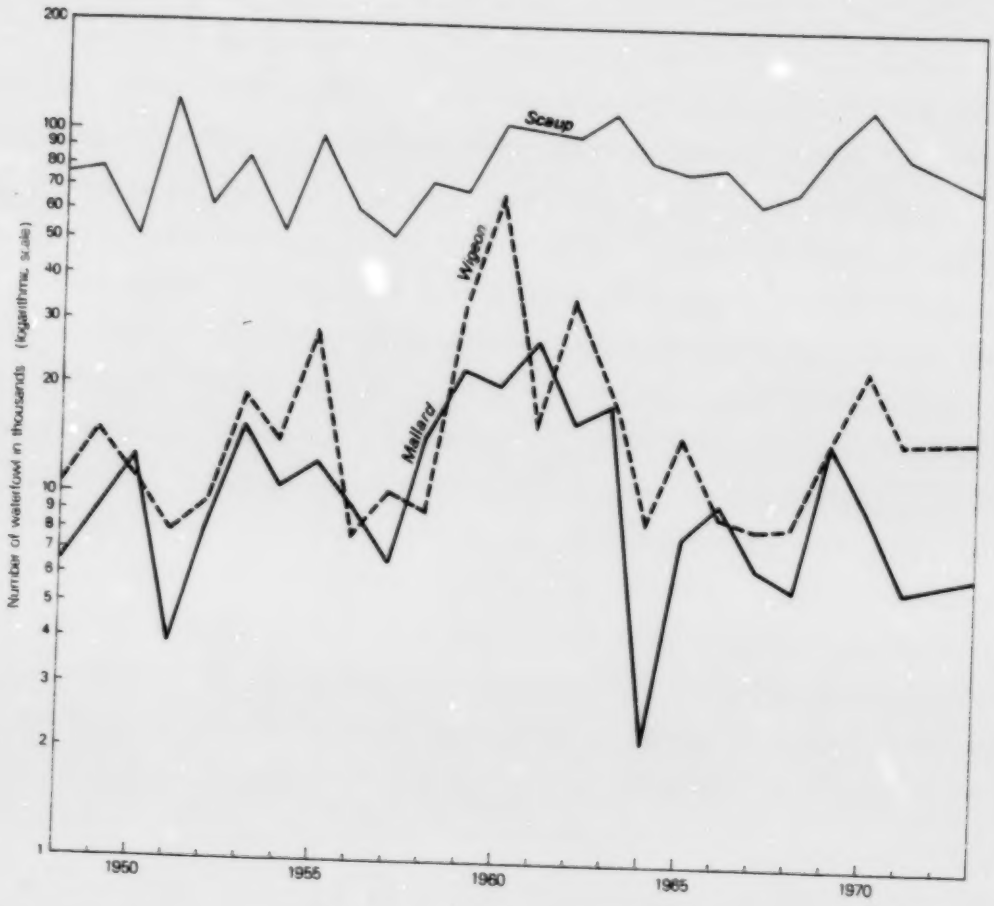


Figure 15. Total Mackenzie Delta and Upland Tundra Indices for Mallard, Wigeon and Scaup, 1948–73, Based on U.S. Fish and Wildlife Service Surveys.

4.3 Ptarmigan

Introduction

Two species of ptarmigan are common in the Delta Region, willow ptarmigan *(Lagopus lagopus)* and rock ptarmigan *(Lagopus mutus)*. Willow ptarmigan are widely distributed throughout forest and tundra areas, while rock ptarmigan are restricted to tundra and are found frequently in coastal areas. The white-tailed ptarmigan *(Lagopus leucurus)* has been reported from the Richardson Mountains in the vicinity of Lapierre House, but there are no reports of its occurrence elsewhere in the Region.

Seasonal Movements

Willow ptarmigan are found primarily on dry shrub and polygon tundra in summer, but are known to nest in forest-tundra and relatively open forested areas. Rock ptarmigan frequent areas of open tundra in summer.

Both willow and rock ptarmigan form flocks in late summer, and by late fall groups of males separate from the larger flocks as ptarmigan move to wintering areas. Willow ptarmigan generally move farther from their nesting areas than rock ptarmigan. The majority of rock ptarmigan males remain near nesting grounds throughout winter or move to tree line, whereas the majority of females winter below tree line. Adult willow ptarmigan males predominate in the flocks that winter nearest tree line, while juvenile males, females and young form flocks which winter farther south. MacFarlane reported that rock ptarmigan wintered in forested areas east of the Anderson River, whereas willow ptarmigan more commonly wintered in forest near Fort Good Hope. In late April and early May, willow ptarmigan in the Delta Region begin to move from tall willow winter habitat to upland shrub tundra. During spring there are often transitional movements between habitats according to weather; upland shrub tundra is used on warm, sunny days and tall willow areas are used on cold days.

Activity Patterns and Food Habits

Captive willow ptarmigan in central Alaska were observed to be active 24 hours a day from May to July and showed no peaks in activity, whereas in winter (November-February), they were only active for a few hours in the middle of the day, showing a peak in activity at sunrise and before sunset. Activity patterns from March to April and from August to October were transitional between the typical summer and winter patterns.

In summer, both willow and rock ptarmigan feed on a wide variety of plants (Tables 6 and 7), but fewer species are consumed in fall. In winter, willow ptarmigan feed almost exclusively on willow buds, primarily of *Salix alaxensis*, while rock ptarmigan feed largely on birch buds, primarily of dwarf birch *(Betula glandulosa)*. Willow ptarmigan maintain this diet through May, but the spring diet of the rock ptarmigan is considerably more varied. This is probably due to early snow melt in exposed locations on the tundra which makes a wide variety of foods available. In summer, willow and rock ptarmigan occupy different habitats so there is no competition for food, and in winter when habitats may overlap to some extent, competition is minimized by their selection of different foods.

Weeden studied willow ptarmigan winter foods from ten locations in Alaska, two in the Yukon, and one in British Columbia. Willow made up an average of 87% (62–100%) of the total food consumed, birch 8% (0–27%), and other foods 5% (0–20%). Dependency of these ptarmigan on willow (as indicated by their name) is characteristic over a wide geographic range. In a study in central Alaska, willow ptarmigan in northern wintering areas ate 96% willow and 3% dwarf birch from November to April, while farther south they ate only 67% willow, but 25% birch. Variations in snow depth and the height of plants may restrict the use of certain willow species and dwarf birch in the north, but farther south, willow and birch reach greater heights and are available throughout winter. The tallest willow, *Salix alaxensis*, was used more extensively as winter progressed and snow depth increased (Table 6). *Salix alaxensis* is a dominant shrub in the Mackenzie Delta and is used intensively by willow ptarmigan in late winter.

In winter, ptarmigan remain in burrows in the snow except for the few hours of light during mid-day when they are active. In shallow hard-packed snow, ptarmigan stay in depressions, but in deep snow they burrow down about a foot and then horizontally. During their short activity period they must consume sufficient food to maintain them until the next day, or even longer during storms. The weight of willow ptarmigan crops reaches its maximum in mid-winter and can be up to 15% of the total weight of the bird. In winter, willow ptarmigan have a 15–16 hour rest period and have a daily food intake of 61–70 g (2.1–2.5 oz) (dry wt.), while rock ptarmigan have a 13–15 hour rest period and ingest 43–44 g (1.5–1.6 oz) (dry wt.) of food per day. Both species have two large outpocketings called caeca at the junction of the small and large intestines, where food not digested in the small intestine ferments. This fermentation provides 6–30% of the basic energy requirements of willow ptarmigan in winter and can allow extended rest periods in times when storms prevent the normal feeding pattern.

Reproduction

Ptarmigan nesting territories are established in late April or early May and boundaries change little as the snow melts. Both willow and rock ptarmigan form pairs which defend territories. In late May or early June hens begin to lay eggs, usually within seven to ten days of each other, although the time of nesting varies from year to year and is correlated with variation in the beginning of plant growth. Six to ten eggs are usually laid, although twelve eggs have been

Table 6. Foods of Willow Ptarmigan in Interior Alaska (after West and Meng 1966).

SPECIES	PERCENT OF DRY WEIGHT[1]									
	June to August	Sept	Oct	Nov	Dec	Jan	Feb	March	April	May
Willow *(Salix alaxensis)*	4	2	+[2]	48	25	47	81	66	74	32
(S. glauca)		18	36	12	4	+	2	2	+	11
(S. pulchra)	+	1	20	30	6	+	+	1	2	11
(S. richardsonii)			22		50	41	5	11	+	8
(S. arbusculoides)		9	4	3	11	8	3	19	14	19
(S. spp.)	43									
Total Willow	47	30	80	92	95	97	100	99	92	82
Dwarf Birch *(Betula glandulosa)*	5	17	10	1	5	3	+	1	5	5
Bog Blueberry *(Vaccinium uliginosum)*	5	49	5							
Mountain Avens *(Dryas integrifolia)*		2	3	6					2	6
Little Horsetail *(Equisetum scripoides)*	16	3	+							
Mountain Cranberry *(Vaccinium vitis-idaea)*	5								+	+
Bearberry *(Arctostaphylos uva-ursi)*	8									
Miscellaneous[3]	13	1	1	1				+	+	1

1. Percents are rounded off to nearest whole numbers

2. + = less than 1%

3. Includes items not represented by over 5% in any month

Table 7. Foods of Rock Ptarmigan in Interior Alaska (after Weeden 1969)

SPECIES	PERCENT OF DRY WEIGHT				
	Early[1] Summer	Late Summer	Autumn	Winter	Spring
Willow *(Salix spp.)*	28	1	11	6	12
Birch *(Betula spp.)*	11	13	51	86	31
Crowberry *(Empetrum nigrum)*	2	25	10	+[2]	16
Bog Blueberry *(Vaccinium uliginosum)*	1	9	13	2	11
Mountain Avens *(Dryas octapetala)*	16	6	3	+	11
Mountain Cranberry *(Vaccinium vitis-idaea)*	8	3	2	1	10
Alpine Bistort *(Polygonum viviparum)*	14	1	2		
Oxytrope *(Oxytropis spp.)*	9	9	+		+
Miscellaneous[3]	11	33	8	5	9

1. Early Summer: 6 June - 31 July
   Late Summer: 1-31 August
   Autumn: 1 September - 10 October
   Winter: 11 October - 9 May
   Spring: 10 May - 5 June

2. + = less than 1%

3. Includes items not represented by over 5% in any month

reported from a willow ptarmigan nest in the Region, and incubation lasts twenty-one to twenty-two days. Clutches may be lost from predation or adverse weather conditions, which in some years can be catastrophic to reproductive success. Barry noted that in the Anderson River Delta in 1969, a late heavy snowfall covered most nests and that flooding followed snow melt, resulting in a nearly total reproductive failure of the willow ptarmigan population in that year. Normally, hens lay only one clutch per year and hens that have lost their clutches rarely re-nest.

After hatching, willow ptarmigan chicks are cared for by both the male and the female, a habit unique among North American grouse. Rock ptarmigan males generally leave the hen and brood, and form flocks with other males and hens that have been unsuccessful in nesting. Ptarmigan can fly at about ten days of age, and brood flocks form in early August. By mid-September, these flocks are joined by the males.

Numbers

Ptarmigan populations generally exhibit major fluctuations in yearly abundance and may fluctuate cyclically over approximately ten years. Weeden and Theberge found that a rock ptarmigan population on a 5.8 km^2 (2.2 mi^2) study area in central Alaska varied from a low of 3/km^2 (8/mi^2) to a high of 7/km^2 (19/mi^2) over a ten-year period. These figures indicate that ptarmigan populations may fluctuate two- to four-fold between years. Local densities may also be very high in favourable habitat, but these values cannot be extrapolated to large areas. A local willow ptarmigan population in northwestern British Columbia has shown variations in spring density of from about 20-76 pairs/km^2 (51-198 pairs/mi^2) over a seven-year period, and in coastal areas of the Mackenzie Delta Region a local density of 106 pairs/km^2 (275 pairs/mi^2) was observed in 1969. There have been no long term studies of ptarmigan populations in the Delta Region and because of large fluctuations in yearly abundance and wide differences in abundance among different habitats, estimates of population densities derived from surveys in some years in different locations have little comparative meaning.

4.4 Annotated List of Species

GAVIIFORMES Loons

Common Loon *Gavia immer*

The common loon breeds in Alaska, Canada, and the northern United States in forests and low arctic tundra. It winters along the coast from Alaska to Baja California, and from Newfoundland to Florida and Texas. Common loons nest infrequently in the forest and rarely on the tundra in the Delta Region.

Yellow-billed Loon *Gavia adamsii*

The yellow-billed loon breeds in tundra regions of Eurasia and North America west of Hudson Bay. In North America it winters from the coast of southeastern Alaska to Vancouver Island. In the Delta Region these loons nest infrequently in the area of Liverpool Bay and Franklin Bay and in the adjacent upland lakes. They have occasionally been observed along other parts of the coast in the Region and in the Mackenzie Delta.

Arctic Loon *Gavia arctica*

The arctic loon breeds in northern circumpolar regions from mid-arctic tundra south to well within tree line. In North America it winters along the coast from Alaska to Baja California. It is the most common loon of the Delta Region and nests throughout the forest and tundra.

Red-throated Loon *Gavia stellata*

The red-throated loon breeds in northern circumpolar regions from the High Arctic south to within tree line. In North America it winters along the coast from the Aleutian Islands to Mexico, and from Newfoundland to Florida and the Gulf of Mexico. It nests throughout the Delta Region, but is most common along the coast.

PODICIPEDIFORMES Grebes

Red-necked Grebe *Podiceps grisegena*

The red-necked grebe breeds in forested areas of northwestern North America, Europe, and northern Asia. In the Western Hemisphere it winters along the coast from the Aleutian Islands to central California, and from Newfoundland to central Florida. It commonly nests in the forested part of the Delta Region, but is rare north of the tree line.

Horned Grebe *Podiceps auritus*

The horned grebe breeds in northern circumpolar regions, primarily in forested areas. In North America it winters along the coast from the Aleutian Islands to southern California and from Nova Scotia to Florida. In the Delta Region it commonly nests in the forested part of the Mackenzie Delta, but is uncommon in other forested areas and rare on the tundra.

PELECANIFORMES Pelicans

White Pelican *Pelecanus erythrorhynchos*

The white pelican breeds in discrete areas from Great Slave Lake through the Prairie Provinces and British Columbia to the southwestern United States. It winters from the southern United States to Guatemala. Individuals have been reported from the Delta Region only rarely; one was collected from Liverpool Bay near the mouth of the Anderson River in 1900, and seven pelicans (probably of this species) were observed in Hansen Harbour in 1972.

ANSERIFORMES Swans, Geese, and Ducks

Whistling Swan *Olor columbianus*

The whistling swan breeds in Alaska and Canada on low arctic tundra, and winters along the coasts of the United States from Washington to California and from Maryland to North Carolina. It commonly nests on the tundra and rarely in the forests of the Delta Region.

Trumpeter Swan *Olor buccinator*

The trumpeter swan presently nests in discrete areas in western North America from southern Alaska to Wyoming; formerly its nesting range was wider and populations were abundant. It winters in some parts of its breeding range. In the 1860's, this species was reported nesting in the Delta Region on the tundra southwest of Franklin Bay and on islands in the Bay; one was collected at Point Stivens on 12 August 1848. There have been recent unconfirmed reports of trumpeter swans nesting in the Region.

Canada Goose *Branta canadensis*

The Canada goose breeds throughout most of northern North America, and winters from southern Canada to northern Mexico and the Gulf Coast of the United States. The species varies greatly in size throughout its range. There are two subspecies in the Delta Region; *B.c. parvipes*

which commonly nests throughout the forest and tundra and *B.c. taverneri* which nests along the Beaufort Sea coast.

Brant *Branta bernicla*

The brant nests in colonies on the tundra in northern circumpolar regions. In the Western Hemisphere it winters along the coast from British Columbia to Baja California, and from Massachusetts to North Carolina. The Pacific subspecies *B.b. nigricans* commonly nests in the Delta Region.

White-fronted Goose *Anser albifrons*

The white-fronted goose breeds in northern circumpolar regions on low arctic tundra, with the exception of parts of the northeastern mainland of Canada and the west coast of Greenland. In the Western Hemisphere it winters from southern British Columbia and southern Illinois, south to Mexico. The common subspecies that nests in the Delta Region is *A.a. frontalis*. The larger, darker form, *A.a. gambelii* or Thule goose, which may be a separate species, has been reported nesting by Loon Channel south of Kendall Island.

Snow Goose *Chen caerulescens*

The snow goose nests in colonies on the tundra from northeastern Siberia to northern Greenland; in North America it winters from British Columbia to California, from New Jersey to South Carolina, and along the Gulf coast from Mexico to western Florida. The subspecies *C.c. caerulescens*, or lesser snow goose, commonly nests on the tundra of the Delta Region. Most snow geese in the Delta Region are of the white phase, but a few blue phase individuals have been recorded.

Ross's Goose *Chen rossii*

The Ross's goose nests in discrete areas in the central Canadian Low Arctic and in small numbers on Banks Island; it winters in the Sacramento and San Joachim valleys of California. It is probably a rare spring migrant through the Anderson River Valley; specimens have been taken in the spring at Fort Anderson in the 1860's and near Cape Bathurst in the early 1900's.

Mallard *Anas platyrhynchos*

The mallard nests throughout most of Europe, Asia and North America generally south of the tundra; it winters within southern portions of its breeding range. Mallards commonly nest

throughout the forested part of the Delta Region and less commonly in tundra areas.

Black Duck *Anas rubripes*

The black duck breeds throughout northeastern North America south of the tree line, and winters from southeastern Canada, through the eastern United States, to Bermuda. This species has been recorded twice from the Delta Region; it was reported from the Anderson River area in the 1860's, and one was seen flying near Arctic Red River in 1973.

Gadwall *Anas strepera*

The gadwall breeds in western North America and Eurasia. In the Western Hemisphere it winters in the southern United States and Mexico. This species has been reported twice from the Delta Region; one was seen on Richards Island in 1973 and another was seen north of Travaillant Lake in June 1975.

Pintail *Anas acuta*

The pintail breeds in the northern forests and low arctic tundra of both North America and Eurasia. In North America it winters from southern Canada southward. This is the most common dabbling duck throughout the Delta Region.

Green-winged Teal *Anas crecca*

The green-winged teal breeds throughout most of North America and Eurasia, generally south of the tundra. In the Western Hemisphere it winters in the United States. In the Delta Region it commonly nests only in the forested part of the Mackenzie Delta. It is uncommon to rare in other areas of forest and on the tundra.

Blue-winged Teal *Anas discors*

The blue-winged teal breeds from southern Canada to the southern United States, and winters from the southern United States south to Ecuador, Brazil and the West Indies. This species has been reported twice from the Delta Region; one was seen near Lapierre House in 1971, and one was seen at Swimming Point (southern Richards Island) in 1973.

American Wigeon *Anas americana*

The American wigeon breeds in northwestern and western North America, generally south of the tundra. It winters from southern Alaska, southern Illinois and southern New England

south to Central America and the West Indies. It commonly nests throughout the Delta Region both in forests and on the tundra.

Northern Shoveler *Anas clypeata*

The northern shoveler breeds across northern Eurasia, throughout northwestern and western North America, and locally in northeastern North America. In the Western Hemisphere it winters from coastal southern British Columbia, Arizona, and coastal southern United States, south to Costa Rica and the West Indies. In the Delta Region, it nests frequently, both in the forest and on the tundra.

Canvasback *Aythya valisineria*

The canvasback breeds in the interior of northwestern and western North America, and winters in central and southern United States. It nests only rarely in the forested part of the Delta Region and in the Anderson River Delta.

Greater Scaup *Aythya marila*

The greater scaup breeds across North America and Eurasia, primarily in northern coniferous forests. In the Western Hemisphere it winters along the coast from southern Alaska to California, and from Newfoundland to Florida and the Gulf of Mexico. It nests quite commonly in the Delta Region, primarily in coastal areas and along the Eskimo Lakes. However, records do not always distinguish between this species and the lesser scaup.

Lesser Scaup *Aythya affinis*

The lesser scaup breeds throughout northwestern and western North America, generally south of the tundra, and winters from the northern United States to northern South America and the West Indies. This species is the most common scaup in the Delta Region and nests in abundance throughout the forests.

Common Goldeneye *Bucephala clangula*

The common goldeneye breeds in northern Eurasia and North America north to about tree line. In the Western Hemisphere it winters from southeastern Alaska and southern Canada to California, the Gulf Coast, and Florida. In the Delta Region it nests occasionally in the forested part of the Mackenzie Delta; in other parts of the Region it is rare.

Barrow's Goldeneye *Bucephala islandica*

Barrow's goldeneye breeds in the mountains of northwestern and western North America, in Labrador, southwestern Greenland, and Iceland. It winters along coasts south of its breeding range. There are only three records of this species from the Delta Region; two specimens were taken near Fort Anderson during spring migration in 1863 and 1864, and one was seen on the Blow River on 25 July 1971.

Bufflehead *Bucephala albeola*

The bufflehead breeds throughout forested areas of northwestern and western North America. It winters along the coast from the Aleutian Islands, and the Maritimes south to Mexico and the Gulf Coast, as well as on the Great Lakes. There are only two records of this species from the Delta Region; Preble saw one 121 km (75 mi) downstream from Fort Good Hope on 26 June 1904, and also observed a female and brood near Fort McPherson on 8 July 1904.

Oldsquaw *Clangula hyemalis*

The oldsquaw breeds on the tundra in northern circumpolar regions. In the Western Hemisphere it winters along the coast from the Aleutian Islands to Washington and from Labrador to South Carolina. It is one of the most abundant ducks nesting on the tundra of the Delta Region, especially near the coast.

Harlequin Duck *Histrionicus histrionicus*

The harlequin duck breeds in the mountainous areas of eastern Siberia and northwestern and western North America, and from southern Baffin Island, Greenland, and Iceland south to Newfoundland. In the Western Hemisphere it winters along the coast from Alaska to central California and from southern Labrador to Massachusetts. This species nests, probably in small numbers, throughout the mountains west of the Mackenzie Delta and has been seen occasionally along the Yukon coast.

Steller's Eider *Polystica stelleri*

Steller's eider breeds in northeastern coastal Siberia and in northwestern and northern coastal Alaska to Point Barrow. In North America it winters off the coast of southwestern Alaska. Anderson received an unconfirmed report of one bird that was shot at Cape Bathurst in the early 1900's. However, there have been no other reports of this species occurring in the

Delta Region.

Common Eider *Somateria mollissima*

The common eider breeds in coastal areas of North America and Eurasia, and winters in parts of its breeding range, and along the Atlantic coast to New York, and in the Bering Sea. In the Delta Region this species nests along the Beaufort Sea coast and on offshore islands, but is more common along the Bathurst Peninsula and in Franklin Bay.

King Eider *Somateria spectabilis*

The king eider breeds along most of the arctic coasts of North America and Eurasia. In the Western Hemisphere it winters in the Bering Sea and in coastal areas of the Atlantic Ocean from Greenland to Newfoundland. King eiders nest occasionally along the coast of the Delta Region. Both king and common eiders are abundant during migrations through the Region.

White-winged Scoter *Melanitta deglandi*

The white-winged scoter breeds in northwestern and western North America. It winters along the coast from the Aleutian Islands to Baja California, and from the Gulf of St. Lawrence to South Carolina, as well as in small numbers on the Great Lakes. This species nests in abundance throughout the Delta Region.

Surf Scoter *Melanitta perspicillata*

The surf scoter breeds in Alaska and in discrete areas in northern Canada, generally south of the tundra. It winters along the coast from the Aleutian Islands to California and from southern Newfoundland to Florida, as well as in small numbers on the Great Lakes. This species nests in abundance throughout the forests of the Delta Region, and aggregates in moulting flocks in tundra areas.

Black Scoter *Melanitta nigra*

The black scoter breeds in boreal forests and low arctic tundra in northern circumpolar regions. In the Western Hemisphere it winters along the coast from the Aleutian Islands to southern California and from Newfoundland to South Carolina, as well as in small numbers on the Great Lakes. This species has occurred rarely, and is not known to nest, in the Delta Region.

Common Merganser *Mergus merganser*

The common merganser breeds in forested regions of Eurasia and North America. In the Western Hemisphere it winters south to southern California, northern Mexico, the Gulf Coast and Florida. During 1974 dense flocks of this species gathered along the north shore of Liverpool Bay and in the Eskimo Lakes area. Kuyt observed thirty-eight birds and collected two male specimens from that area. There are no other records of this species in the Delta Region and it was assumed that these flocks were in an aberrant moult migration.

Red-breasted Merganser *Mergus serrator*

The red-breasted merganser breeds throughout the northern forests and low arctic tundra of North America and Eurasia. In the Western Hemisphere it winters primarily along the coast, from southern Canada to the southern United States. In the Delta Region it nests commonly in the forested part of the Mackenzie Delta, and occasionally along rivers north of the tree line and on the coast.

FALCONIFORMES Hawks and Falcons

Goshawk *Accipiter gentilis*

The goshawk breeds throughout the forests of North America and Eurasia, and winters within its breeding range and somewhat farther south. The species is an uncommon year round resident of the forested part of the Delta Region.

Sharp-shinned Hawk *Accipiter striatus*

The sharp-shinned hawk breeds throughout the forests of North America and in the Greater Antilles. It nests rarely in the mountains west of the Mackenzie River. Preble observed one bird below the site of old Fort Good Hope on 28 June 1904, and noted that a specimen had been taken at Lapierre House. Godfrey collected a first year male near Mt. Goodenough in the Richardson Mountains on 26 August 1958, and observed several other individuals. A single hawk was seen in the northern Yukon in 1972 and 1974.

Red-tailed Hawk *Buteo jamaicensis*

The red-tailed hawk breeds from near tree line in Alaska and Canada south to Panama and the West Indies. It winters within the southern part of its breeding range. This species has been

recorded three times from the Delta Region: Preble saw one bird below Fort Good Hope on 25 June 1904, Hohn and Robinson observed one bird near Aklavik on 13 July 1949, and one bird was seen on upper Rapid Creek on 1 May 1974.

Broad-winged Hawk *Buteo platypterus*

The broad-winged hawk breeds in forests of North America east of the Rocky Mountains and in the West Indies. It winters from southern Mexico to northwestern South America. This species has been reported once from the Delta Region; McEwen observed one bird at Kendall Island on 2 July 1954.

Swainson's Hawk *Buteo swainsoni*

Swainson's hawk breeds in discrete areas of northwestern North America and throughout western Canada and the western United States; it winters in Argentina. This species has been recorded once from the Delta Region. MacFarlane reported finding a nest in the 1860's on the principal tributary of the Carnwath River, about 32 km (20 mi) southeast of Fort Anderson.

Rough-legged Hawk *Buteo lagopus*

The rough-legged hawk nests throughout the northern forests and low to mid-arctic tundra of North America and Eurasia. In the Western Hemisphere it winters from southern Canada to the southern United States. This species prefers rocky outcrops and steep riverbanks for nesting and is common throughout the Delta Region wherever such sites occur.

Golden Eagle *Aquila chrysaetos*

The golden eagle breeds in discrete areas throughout Eurasia south to northern Africa, and in North America south to central Mexico; it winters within the southern part of its breeding range. This species is generally uncommon throughout the Delta Region, but nests where rocky outcrops, steep riverbanks, or bluffs provide favourable habitat.

Bald Eagle *Haliaeetus leucocephalus*

The bald eagle breeds in discrete areas within the forests of North America and winters in the southern part of its breeding range. This species nests occasionally within the forested part of the Delta Region, but has been observed north of tree line to the coast.

Marsh Hawk *Circus cyaneus*

The marsh hawk breeds throughout most of North America and Eurasia, generally south of the tundra. In the Western Hemisphere it winters from southern Canada to Columbia and the West Indies. This species nests only rarely in the Delta Region. There are records of nesting birds in the Anderson River Delta and it has occasionally been seen in other tundra areas.

Osprey *Pandion haliaetus*

The osprey occurs in tropical and temperate parts of all continents. In the Western Hemisphere it breeds in most of Alaska and the Mackenzie District of the Northwest Territories across Canada and south to the Bahamas, Mexico, and the British Honduras. It winters from the southern United States to the West Indies and South America. In the Delta Region it has been reported from Shingle Point and the Blow River in 1973 and from north of Travaillant Lake in 1975.

Gyrfalcon *Falco rusticolus*

The gyrfalcon breeds in tundra and montane regions throughout North America and Eurasia. In the Western Hemisphere it winters from its breeding grounds to southern Canada. This species prefers steep bluffs and cliffs for nesting and is found throughout the Delta Region wherever suitable sites occur. Adults may overwinter in the Region where prey species are sufficiently abundant. Gyrfalcon activity was studied during part of one winter on the Yukon North Slope by Platt.

Peregrine Falcon *Falco peregrinus*

The peregrine falcon breeds throughout North America, South America, Eurasia, Africa, Australia, and on many islands. In North America it winters north to the northern United States, southern British Columbia, and Ontario. Populations of this species have been exterminated in parts of their southern range and drastically reduced in much of their northern range, principally from the effects of certain pesticides on reproductive success. The peregrine falcon is classed as an endangered species. Peregrine falcons prefer cliffs for nesting and are found throughout the Delta Region wherever suitable sites occur in habitat in which prey populations are abundant.

Merlin *Falco columbarius*

The merlin breeds in the northern forests of North America and Eurasia. In the Western Hemisphere it winters in southern British Columbia and from the southern United States to the West Indies and northern South America. In the Delta Region this species nests occasionally within forested areas, and sometimes wanders north of tree line to the coast.

American Kestrel *Falco sparverius*

The American kestrel breeds throughout the forests of North and South America and winters from southern Canada southward. This species is an uncommon transient in the Delta Region, and probably does not nest. It has been recorded from Lapierre House in the vicinity of Fort McPherson, Fort Good Hope, Mt. Goodenough, Aklavik, Reindeer Station, Richards Island and the Anderson River Delta.

GALLIFORMES Grouse and Ptarmigan

Spruce Grouse *Canachites canadensis*

The spruce grouse is a year round resident of coniferous forests in northern North America. This species is a rare and irregular winter visitor to the Mackenzie Delta, although it is a common resident somewhat farther south.

Ruffed Grouse *Bonasa umbellus*

The ruffed grouse is a year round resident of the forests of North America with the exception of those of the southern and southwestern United States. In the Delta Region, this species has been recorded only once, from Lapierre House.

Willow Ptarmigan *Lagopus lagopus*

The willow ptarmigan is a year round resident on low to mid-arctic tundra and in boreal forest in northern circumpolar regions. It nests throughout the Delta Region, generally north of tree line, and is the most abundant ptarmigan in the Region in both summer and winter.

Rock Ptarmigan *Lagopus mutus*

The rock ptarmigan breeds in arctic and alpine tundra throughout Eurasia and northwestern North America. It is essentially resident throughout its range. In the Delta Region this species occurs primarily along the arctic coast and on offshore islands and has been only

rarely observed south of tree line.

White-tailed Ptarmigan *Lagopus leucurus*

The white-tailed ptarmigan is resident in the mountains of northwestern and western North America. In the Delta Region it has been observed in the vicinity of Lapierre House in the 1860's and once near Reindeer Station in 1934.

Sharp-tailed Grouse *Pedioecetes phasianellus*

The sharp-tailed grouse is resident from north-central Alaska to western Quebec and south to eastern Oregon and northern Michigan, its range formerly extended farther south. Northern populations may sometimes be migratory. This species is resident throughout the forested part of the Delta Region.

GRUIFORMES Cranes

Whooping Crane *Grus americana*

The whooping crane formerly nested in western North America and wintered along the Gulf Coast. Presently it is near extinction and known to breed only in Wood Buffalo National Park and to winter in the Arkansas National Wildlife Refuge on the coast of Texas. In the 1860's, this species was observed to migrate past Fort Good Hope and Fort Anderson and probably nested in the Delta Region, possibly in the Anderson River Delta where two individuals were reported in 1949.

Sandhill Crane *Grus canadensis*

The sandhill crane breeds from northeastern Siberia and low to mid-arctic Canada, south to the northwestern United States, and from the southern United States to Cuba. The species winters from the southern United States to central Mexico and Cuba. In the Delta Region the sandhill crane commonly nests on the tundra of the Mackenzie Delta and occasionally in other tundra areas.

CHARADRIIFORMES Shorebirds, Gulls, and Auks

Semipalmated Plover *Charadrius semipalmatus*

The semipalmated plover breeds in northern forests and on low to mid-arctic tundra across Alaska and Canada, and winters from southern California, the Gulf Coast, and South

Carolina to southern Argentina and Chile. This species commonly nests in the Delta Region, primarily along the arctic coast.

Killdeer *Charadrius vociferus*

The killdeer breeds from southern Canada to central Mexico, the Gulf of Mexico, and the West Indies; it also breeds in Peru. It winters from southern British Columbia to Long Island south to northern South America. This species has been reported only occasionally from the Delta Region. It has been recorded from Aklavik, Richards Island, and the Anderson River Delta. However, a female in juvenile plumage was collected at Aklavik on 18 August 1958 indicating that killdeer may sometimes nest in the Region.

American Golden Plover *Pluvialis dominica*

The American golden plover breeds in northern forests and on low to mid-arctic tundra in northern Siberia, Alaska, and northern Canada. In the Western Hemisphere it winters on the South American plains from southern Bolivia and southern Brazil to central Argentina. This species commonly nests on the upland tundra of the Delta Region.

Black-bellied Plover *Pluvialis squatarola*

The black-bellied plover breeds on the low to mid-arctic tundra of northern circumpolar regions. In the Western Hemisphere it winters along the coast from British Columbia to Chile and from New Jersey to southern Brazil. This species has nested infrequently in the Anderson River Delta, on Cape Bathurst, and at Franklin Bay. It has also been observed at a number of scattered locations along and near the coast.

Ruddy Turnstone *Arenaria interpres*

The ruddy turnstone breeds in coastal Alaska, mid to high arctic Canada, Greenland, Iceland, along the north coast of Europe and northern Siberia. In the Western Hemisphere it winters from southern United States to Chile and southern Brazil. In the Delta Region the species is a rare migrant along the coast. MacFarlane reported that in the 1860's it nested on the shores of Liverpool and Franklin bays and on the lower Anderson River, but the evidence is not conclusive.

Black Turnstone *Arenaria melanocephala*

The black turnstone breeds on the coast of western and southern Alaska and winters along the coast from southeastern Alaska to northern Mexico. The species has been reported only once from the Delta Region, near Tununuk Point on 3 August 1970.

Common Snipe *Capella gallinago*

The common snipe breeds through the forests of northern and central North America and Eurasia. In the Western Hemisphere it winters from southern British Columbia and the northern United States to the West Indies and northern and central South America. It commonly nests throughout the forested part of the Delta Region, but is uncommon to rare north of the tree line.

Whimbrel *Numenius phaeopus*

The whimbrel breeds on low arctic tundra in northern circumpolar regions, although its range is not continuous. In the Western Hemisphere it winters from the southern United States to the Galapagos Islands, southern Chile, and Brazil. In the Delta Region it commonly nests on upland tundra.

Eskimo Curlew *Numenius borealis*

The Eskimo curlew is almost extinct. Formerly it nested in the northwestern Mackenzie District and wintered from southern Brazil to southern Argentina and Chile. Overhunting during migration appears to have been the most likely cause of its decline. In the Delta Region this species was reported to breed abundantly on upland tundra east of Fort Anderson in the 1860's. Four observations of birds that were possibly Eskimo curlews in the Anderson River Delta from 1960–65 suggest that this species may still nest in the Region.

Upland Plover *Bartramia longicauda*

The upland plover breeds from southern Alaska and southern Canada to northern Texas and Maryland; it winters in southern South America. This species has been reported during three surveys in the Delta Region; several were seen at the base of the Richardson Mountains southwest of Aklavik in June and again in July 1971, and at least one bird was seen in the summer of 1974 southwest of Aklavik.

Spotted Sandpiper *Actitis macularia*

The spotted sandpiper breeds throughout most of North America south of the tundra, and winters from southwestern British Columbia and the southern United States to northern Chile and southern Brazil. In the Delta Region, this species commonly nests in the forests, but is rarely seen north of tree line.

Solitary Sandpiper *Tringa solitaria*

The solitary sandpiper breeds in the northern forests of North America and winters from Baja California to Georgia and to Argentina. This species is rare in the Delta Region, and probably does not nest. It has been observed only along the Babbage River, at Cache Creek, in the Mackenzie Delta, on Richards Island and east of Fort McPherson.

Greater Yellowlegs *Tringa melanoleuca*

The greater yellowlegs breeds in wooded muskeg in southern Alaska and across Canada, and winters from the southern United States to southern South America. There are three reports of this species from the Delta Region; a pair with four young were found in the inner delta of the Anderson River in 1963, an unconfirmed observation of a pair was made near Travaillant Lake in 1973, and one bird was seen near Inuvik in 1974.

Lesser Yellowlegs *Tringa flavipes*

The lesser yellowlegs breeds in Alaska and northern Canada east to James Bay, generally south of tree line. It winters from the southern United States to Chile and Argentina. This species commonly nests throughout the forested part of the Delta Region, but has only rarely been seen north of tree line to the coast.

Red Knot *Calidris canutus*

The red knot breeds on the tundra in northern circumpolar regions. In the Western Hemisphere it winters along the coast from California to southern South America, and rarely from Massachusetts to South America. It has been reported once from the Delta Region; one was seen in August 1972 at Moose Channel.

Sharp-tailed Sandpiper *Calidris acuminata*

The sharp-tailed sandpiper breeds in northern Siberia and winters south to Australia and New Zealand. This species has been reported twice from the Delta Region; one was seen on

northern Richards Island during the fall migration in 1972, and another was seen in the same year at Moose Channel.

Pectoral Sandpiper *Calidris melanotos*

The pectoral sandpiper breeds mainly on coasts in eastern Siberia and northern and western Alaska, and on low to mid-arctic tundra in Canada, east to Hudson Bay. In the Western Hemisphere it winters in southern South America. This species commonly nests along the coast in the Delta Region, and large numbers of birds have been observed migrating through the Region.

White-rumped Sandpiper *Calidris fusciocollis*

The white-rumped sandpiper breeds on low to mid-arctic tundra across North America. In the Delta Region, this species has occasionally nested along the coasts of Liverpool and Franklin bays and possibly near Tuktoyaktuk.

Baird's Sandpiper *Calidris bairdii*

Baird's sandpiper breeds in tundra regions from northeastern Siberia through northern Alaska and Canada to northwestern Greenland, and winters in western and southern South America. This species occasionally nests on tundra in the Delta Region.

Least Sandpiper *Calidris minutilla*

The least sandpiper breeds in the northern forests and low arctic tundra of northern North America and winters from the southern United States to central Peru and Brazil. It is an uncommon nester in the Delta Region.

Dunlin *Calidris alpina*

The dunlin breeds along the arctic coast of northwestern North America, on the tundra of the central Canadian Arctic, in Greenland, Iceland, the British Isles, the Baltics, and northern parts of Russia and Siberia. In the Western Hemisphere it winters along the coast from southern Alaska to Baja California, and from Massachusetts to Florida and the Gulf Coast. This species has been observed at Tuktoyaktuk in 1970, on Richards Island in 1972, near the Blow River in 1974, and at Inuvik in 1974. Reed reported that eggs of this species were taken near Fort McPherson in 1899 and Godfrey noted that dunlin had been reported nesting on Baillie Island.

Semipalmated Sandpiper *Calidris pusilla*

The semipalmated sandpiper breeds on low arctic tundra across North America and winters from the southern United States and the West Indies to northern Chile and southern Brazil. This species commonly nests on the tundra of the Delta Region.

Western Sandpiper *Calidris mauri*

The western sandpiper breeds on the coast of western and northern Alaska and winters from the coasts of California, North Carolina, and the Gulf Coast south to Venezuela and Peru. It is a rare spring migrant through the Delta Region.

Sanderling *Calidris alba*

The sanderling breeds on arctic tundra in northern circumpolar regions. In the Western Hemisphere it winters from southern British Columbia to Massachusetts south to southern Chile and southern Argentina. This species is rare in the Delta Region, but has been reported nesting on the Bathurst Peninsula and near Tuktoyaktuk.

Long-billed Dowitcher *Limnodromus scolopaceus*

The long-billed dowitcher breeds in northeastern Siberia, northwestern coastal Alaska and northwestern Mackenzie District. It winters from the southern United States through Mexico to Guatemala. This species probably nests rarely throughout the Delta Region; it has been reported to nest on the Yukon North Slope and south of the Eskimo Lakes and east to the Anderson River Delta and to Franklin Bay. Large numbers of birds migrate through the Region.

Stilt Sandpiper *Micropalama himantopus*

The stilt sandpiper breeds on low arctic coastal tundra from northwestern Alaska to western Hudson Bay, and winters in South America. This species has been reported to nest in the Mackenzie Delta, the Anderson River area and west of the Blow River.

Buff-breasted Sandpiper *Tryngites subruficollis*

The buff-breasted sandpiper breeds in parts of northern Alaska and the western Canadian Arctic, and winters in central Argentina. In the Delta Region this species occasionally nests on the Yukon North Slope, in the Anderson River Delta and on Bathurst Peninsula, and is an uncommon to rare transient in other tundra areas.

Bar-tailed Godwit *Limosa lapponica*

The bar-tailed godwit breeds in northern Eurasia and western and northern Alaska, and winters from southern Eurasia south to Australia and New Zealand. This species has been reported only once from the Delta Region, in the Anderson River Delta.

Hudsonian Godwit *Limosa haemastica*

The Hudsonian godwit breeds in parts of southern Alaska, northwestern Mackenzie District, and southern Hudson Bay. It winters in South America. In the Delta Region, this species nests occasionally in forest and on tundra near the Anderson River and has been seen only rarely in other tundra areas.

Red Phalarope *Phalaropus fulicarius*

The red phalarope breeds on coastal arctic tundra in northern circumpolar regions and winters off both coasts of South America and the coast of western Africa. This species occasionally nests on the coastal tundra of the Delta Region and is a common spring migrant along the Yukon North Slope.

Northern Phalarope *Lobipes lobatus*

The northern phalarope breeds in forests near tree line and in low arctic tundra in northern circumpolar regions. It winters at sea in both Hemispheres, mainly south of the equator. This shorebird commonly nests throughout the tundra and rarely in the forested part of the Delta Region.

Pomarine Jaeger *Stercorarius pomarinus*

The pomarine jaeger breeds on low to mid-arctic tundra in northern circumpolar regions. It winters off the coast of North Carolina south to the West Indies and to Peru, and off the coast of Africa and of eastern Australia. This species has been reported to nest at Baillie Island and has been observed commonly during spring migration along the Yukon coast and on the west side of Franklin Bay. Some 6,000 birds were estimated to have passed Cape Dalhousie during a survey in 1972.

Parasitic Jaeger *Stercorarius parasiticus*

The parasitic jaeger breeds on low to mid-arctic tundra in northern circumpolar regions. It winters in the Atlantic Ocean from the coasts of Maine and the British Isles, to Argentina and

southern Africa. It also winters in the Pacific Ocean from the coast of Baja California to southern Chile, Australia, and New Zealand. This species commonly nests on the tundra of the Delta Region.

Long-tailed Jaeger *Stercorarius longicaudus*

The long-tailed jaeger breeds on low to mid-arctic tundra in northern circumpolar regions. It winters in the Atlantic and Pacific oceans, most commonly in the Southern Hemisphere. This species commonly nests on the tundra of the Delta Region.

Glaucous Gull *Larus hyperboreus*

The glaucous gull breeds on arctic coastal tundra in northern circumpolar regions. In the Western Hemisphere it winters from the southern parts of its breeding range to southern California and New York. This species commonly nests, singly and in colonies, along the arctic coast of the Delta Region and along the Eskimo Lakes.

Slaty-backed Gull *Larus schistisagus*

The slaty-backed gull breeds from northeastern Siberia to Japan and winters within the southern part of its breeding range. The only record of this species for the Delta Region, or for Canada, is an adult male reported to have been collected by Captain H. H. Bodfish, a whaler, in Franklin Bay on 9 June 1901. Bent reported that Bodfish also collected eggs from two nests and the parent birds in Harrowby Bay on 11 June 1901. These specimens may have been collected in Siberia and mislabelled since Bodfish visited the Siberian coast on the same trip and his specimens were often incorrectly labelled.

Herring Gull *Larus argentatus*

The herring gull breeds throughout the forest and low arctic tundra of most of Canada and northeastern United States, Iceland, Europe, and northern Siberia. In the Western Hemisphere it winters from southern parts of its breeding range to the West Indies and Panama. This gull commonly nests, singly or in colonies, on islands in large lakes in the forested part of the Delta Region. It is occasionally seen north of tree line.

Thayer's Gull *Larus thayeri*

Thayer's gull breeds in mid to high arctic regions of Canada and northwestern Greenland, and winters along the coast from British Columbia to California. This gull is a rare migrant along

the coast of the Delta Region.

Ring-billed Gull *Larus delawarensis*

The ring-billed gull breeds from southern and western Canada to the northern and western United States, and winters in the United States and Mexico. This species has been reported only once from the Delta Region; one was seen on Richards Island in 1972.

Mew Gull *Larus canus*

The mew gull breeds in northwestern North America and in most of Eurasia south of the Arctic Circle. In the Western Hemisphere it winters along the coast from southeastern Alaska to southern California. This species commonly nests along lakes throughout the forested part of the Delta Region and is only rarely seen north of tree line.

Bonaparte's Gull *Larus philadelphia*

Bonaparte's gull breeds throughout the forests of western and central Alaska, and of northwestern to northcentral Canada. It winters from southern British Columbia to Massachusetts south to northern Mexico, Cuba, Haiti, and Bermuda. The species occasionally nests in trees in the forested part of the Delta Region, and is only rarely seen north of tree line.

Ivory Gull *Pagophila eburnea*

The ivory gull breeds in northern circumpolar regions but is rare throughout its range. It winters over northern drift-ice and along the edge of pack-ice. The exact status of this species in the Delta Region is unknown. Richardson observed it at Atkinson Point on 13 July 1826, and there have been reports that it is not uncommon in fall and winter in offshore leads. Ivory gulls have been observed recently in the Beaufort Sea off the coast of Alaska during summer, three birds were seen at Moose Channel in August 1972, and one was seen at Shingle Point on 7 September 1973.

Sabine's Gull *Xema sabini*

Sabine's gull breeds on low to mid-arctic tundra in northern circumpolar regions. Its winter range is poorly known, but includes coastal Peru. This species is generally rare in the Delta Region, but nests in colonies in some locations along the coast. Colonies have been observed on Pelly Island sandspit, Atkinson Point, near Cape Bathurst, and along the coast of Liverpool and Franklin bays. It has also been observed along the coast during migration and

6,400 birds were estimated to have passed Cape Dalhousie during a survey in 1972.

Common Tern *Sterna hirundo*

The common tern breeds widely over the Northern Hemisphere of both North America and Eurasia south of the tundra. In the Western Hemisphere it winters from Baja California and South Carolina south to the Straits of Magellan. MacFarlane reported common terns nesting in the forest and tundra of the Anderson River area in the 1860's and Preble noted that a specimen was taken on the coast near the mouth of the Anderson River. Both authors also record the arctic tern from the same region, and it is possible that these birds may have been misidentified as the two species are very similar.

Arctic Tern *Sterna paradisaea*

The arctic tern breeds in northern forests and on arctic tundra in northern circumpolar regions, and winters in the oceans of the Southern Hemisphere. This species makes one of the longest migrations of any bird, from north of the Arctic Circle to south of the Antarctic Circle. The arctic tern commonly nests along lakes throughout the Delta Region.

Caspian Tern *Hydroprogne caspia*

The caspian tern breeds in some locations in North America, Europe, Asia, Africa, Australia, and New Zealand. In the Western Hemisphere it winters from central California through Baja California, to the Gulf of Mexico, the Carribbean and the West Indies. A possible occurrence of this species in the Delta Region has been reported. On 1 August 1848, Richardson saw a large tern on the East Channel near the Caribou Hills which may have been a Caspian tern.

Thick-billed Murre *Uria lomvia*

The thick-billed murre breeds in coastal areas in northern circumpolar regions south to the Aleutian Islands and the Gulf of St. Lawrence. In the Western Hemisphere it winters off the coast from its breeding range to southeastern Alaska and Delaware. This species is a rare migrant along the coast of the Delta Region. The only known nesting colony in the western Canadian Arctic consists of 100-150 birds at Cape Parry, east of the Delta Region.

Black Guillemot *Cepphus grylle*

The black guillemot breeds in coastal areas in northern circumpolar regions south to northern Siberia, northern Alaska, Maine, and southern Scandinavia. It winters off coasts within its breeding range and slightly farther south. Until recently, this species was not known to nest east of the Bering Straits in the western Arctic. The first nest at Point Barrow, Alaska, was recorded in 1966 and nesting has since been recorded east of Point Barrow. In the Delta Region this species has been reported nesting in recent years in discarded oil drums at Herschel Island. The majority of nests found have been in man-made debris; the increase in numbers nesting and extension of range in recent years have been attributed to man-made debris along the Beaufort Sea Coast.

Least Auklet *Aethia pusilla*

The least auklet breeds on the coasts of the Bering Sea and winters within its breeding range. This species has only been reported once from the Delta Region: a specimen was found on the ice near Kittigazuit in 1927.

STRIGIFORMES Owls

Great Horned Owl *Bubo virginianus*

The great horned owl is resident throughout the forests of North and South America although it makes seasonal movements. This species is an uncommon resident in the forests of the Delta Region and has been observed only rarely north of tree line.

Snowy Owl *Nyctea scandiaca*

The snowy owl breeds on arctic tundra in northern circumpolar regions. In the Western Hemisphere it winters from its breeding range to the northern United States. In the Delta Region this species nests occasionally, but is a common winter resident in years when small mammals are abundant. It migrates south to overwinter when food is scarce.

Hawk Owl *Surnia ulula*

The hawk owl breeds throughout the northern coniferous forests of North America and Eurasia. In the Western Hemisphere it winters from its breeding range to southern Canada and the northern United States. This species is an uncommon resident of the forests of the Delta

Region and has been observed only rarely north of tree line.

Great Gray Owl *Strix nebulosa*

The great gray owl is a resident of the northern coniferous forests of North America and Eurasia. In the Delta Region it has been reported from Lapierre House, Fort McPherson, Reindeer Station and Carnwath River.

Short-eared Owl *Asio flammeus*

The short-eared owl breeds throughout North and South America, Eurasia, and the Hawaiian Islands. It moves south in winter from the northernmost part of its range. The species commonly nests on the tundra of the Delta Region in years when food is abundant. One was reported nesting near Lapierre House in 1971 and another nest of this species was found on Richards Island in 1975. Short-eared owls have also been observed in summer on the Yukon North Slope, and in the vicinity of Fort McPherson.

Boreal Owl *Aegolius funereus*

The boreal owl breeds in the northern coniferous forests of North America and Eurasia. In the Western Hemisphere it winters in scattered locations from its breeding range south to the northern United States. The species nests occasionally in the forested part of the Delta Region; nests have been reported only from the area of Lapierre House and Fort Anderson. It has also been seen near Fort McPherson, Aklavik, and between Fort Anderson and Fort Good Hope.

CAPRIMULGIFORMES Goatsuckers

Common Nighthawk *Chordeiles minor*

The common nighthawk breeds from southern Canada south to southern California, northern Mexico, Puerto Rico, Jamaica, and the Bahamas. It winters in South America. This species has been reported once from Lapierre House, twice from Fort Good Hope, and once from the Yukon North Slope on 12 September 1973.

CORACIIFORMES Kingfishers

Belted Kingfisher *Megaceryle alcyon*

The belted kingfisher breeds in forests throughout North America and winters from its breeding range south through the West Indies to Panama. The species is rare in the Delta Region

and there are no records of it nesting. It has been reported from near Lapierre House, near Fort McPherson, west of Aklavik, on the East Channel near the Caribou Hills, near Fort Anderson, and southwest of Aklavik.

PICIFORMES Woodpeckers

Common Flicker *Colaptes auratus*

The common flicker breeds throughout North America south of tree line and on Cuba and Grand Cayman. It winters within its southern breeding range. The species nests occasionally throughout the forests of the Delta Region and has been observed only rarely north of tree line.

Hairy Woodpecker *Dendrocopos villosus*

The hairy woodpecker breeds from near tree line in Alaska and Canada south to Panama and the Bahamas. It winters within its southern breeding range. In the Delta Region this species has only been observed near the Anderson River Delta.

Northern Three-toed Woodpecker *Picoides tridactylus*

The northern three-toed woodpecker is a year round resident in coniferous forests in North America and Eurasia, and breeds north to tree line. It is an uncommon resident in the forested part of the Delta Region.

PASSERIFORMES Perching Birds

Western Kingbird *Tyrannus verticalis*

The western kingbird breeds from southwestern Canada south to Baja California and east to northwestern Ohio. It winters from Mexico south to Nicaragua. This species has been reported only once from the Delta Region, at Cape Dalhousie in 1972.

Say's Phoebe *Sayornis saya*

The Say's phoebe breeds from central Alaska and northwestern Mackenzie District south through the Canadian prairies to northern Mexico. It winters in southwestern United States and Mexico. The species nests in some locations in forest and on tundra in the Delta Region, often on cabins or buildings in settlements.

Alder Flycatcher *Empidonax alnorum*

The alder flycatcher breeds throughout the northern coniferous forests of Alaska, Canada, and northeastern United States, and winters from southern Mexico to Argentina. There is only one record of this species nesting in the Delta Region from near Fort McPherson.

Olive-sided Flycatcher *Nuttallornis borealis*

The olive-sided flycatcher breeds in woodlands from Alaska to Newfoundland and south to northern New Mexico, Minnesota, and Massachusetts, and in montane regions to North Carolina and Tennessee. It winters in South America. This species has been reported only once from the Delta Region; one was seen near Travaillant Lake in 1973.

Horned Lark *Eremophila alpestris*

The horned lark breeds in open terrain throughout North America, Columbia, Eurasia and northern Africa. In North America it winters from southern Canada southward. This species nests occasionally on the tundra of the Delta Region, near Herschel Island, on the Tuktoyaktuk Peninsula, on Nicholson and Bathurst peninsulas, and on the Yukon North Slope. It was observed frequently at Toker Point in the fall of 1972, but has only occasionally been reported from other tundra areas in the Delta Region.

Tree Swallow *Iridoprocne bicolor*

The tree swallow breeds throughout North America south of tree line, and winters from the southern United States south to Nicaragua, Honduras, and Cuba. This species is rare in the Delta Region and is not known to nest. It was seen near Aklavik during the summers of 1947-50, at Babbage River in 1972 and 1973, at Herschel Island in a mixed flock with bank swallows in 1973, on Richards Island in 1973, north of Fort Good Hope in 1974, and north of Travaillant Lake in 1975.

Bank Swallow *Riparia riparia*

The bank swallow breeds throughout North America and Eurasia south of tree line. In the Western Hemisphere it winters in South America. This species commonly nests throughout the forested part of the Delta Region and only rarely on the tundra. One or two birds have been seen occasionally on the Yukon North Slope, and flocks of two to forty birds were observed in August 1973, flying east past Herschel Island.

Barn Swallow *Hirundo rustica*

The barn swallow breeds from southern Canada south to central Mexico, and across Eurasia from near tree line south to northern Africa and northern China. In the Western Hemisphere it winters in South America. This species was observed in the Anderson River Delta in 1958. MacFarlane reported in 1908 that it formerly arrived each spring at Fort Good Hope; however, Godfrey locates the northern limits of its present breeding range at Norman Wells.

Cliff Swallow *Petrochelidon pyrrhonota*

The cliff swallow breeds throughout North America, generally south of the tundra, and winters in South America. This species commonly nests on cliffs and buildings throughout the forested part of the Delta Region and has been observed only rarely north of tree line; observations at Cache Creek and the Babbage River, from 1971 to 1974, suggest that cliff swallows nest in those areas.

Gray Jay *Perisoreus canadensis*

The gray jay is a resident of woodlands throughout Alaska, Canada, and western and northeastern United States. This species is a common resident of the forested part of the Delta Region, but has been observed only rarely north of tree line.

Common Raven *Corvus corax*

The common raven is a resident of much of North America and Eurasia from the high Arctic to the Tropics. This species is a common year-round resident in the Delta Region especially near settlements.

Gray-headed Chickadee *Parus cinctus*

The gray-headed chickadee is a resident of northern forests from Norway east across Eurasia and Alaska to the extreme northwestern part of the Mackenzie District. This species is an uncommon to rare resident of the forested part of the Delta Region, but has been observed only rarely north of tree line.

Boreal Chickadee *Parus hudsonicus*

The boreal chickadee is a resident of coniferous forests in Alaska, Canada, and the northern United States. It is an uncommon resident of the forested part of the Delta Region and has been observed only rarely north of tree line.

Dipper *Cinclus mexicanus*

The dipper breeds along streams and lakes in montane regions of western North and Central America from the Aleutian Islands, north to central Alaska and north central Yukon south to Panama. It winters within most of its breeding range including the Yukon. It has only been reported once from the Delta Region; one was observed at an open spring on the Babbage River on 22 October 1975. Previously, its northern-most record in the Yukon was from the Old Crow region.

Rock Wren *Salpinctes obsoletus*

The rock wren breeds in rocky outcrops, cliffs and hard earth banks from southwestern Canada through the western United States and Mexico to Costa Rica. It winters from the northwestern United States southward. This species has been reported only once from the Delta Region; one was seen a few miles north of Stanton in July 1955.

Robin *Turdus migratorius*

The robin breeds throughout North America south of tree line and in some locations on low arctic tundra. It winters from southern Canada to Florida and Guatemala. This species commonly nests throughout the forested part of the Delta Region; there are few records of it nesting on the tundra.

Varied Thrush *Ixoreus naevius*

The varied thrush breeds in woodlands from Alaska and northwestern Canada to the northwestern United States, and winters from southern British Columbia to northern Baja California. In the Delta Region this species commonly nests throughout the forested part of the Mackenzie Delta and adjacent uplands. It has been observed on the North Slope at Babbage River and may have nested in that area; it has been seen occasionally on the tundra of Richards Island.

Hermit Thrush *Catharus guttatus*

The hermit thrush breeds in forests from central Alaska across Canada to Newfoundland southwest to California and New Mexico and southeast to Minnesota and Maryland. It winters from the southern parts of its breeding range to Baja California, Guatemala and Florida. This species has been reported only once from the Delta Region, from southwest of Aklavik in the summer of 1974.

Swainson's Thrush *Catharus ustulatus*

Swainson's thrush breeds in forests in Alaska, Canada, and the northern United States, and winters from Mexico to northwestern South America. This species occurs only rarely in the Delta Region; it has been reported from Lapierre House, Fort McPherson, Cache Creek, Richards Island and north of Travaillant Lake. Preble reported in 1908 that a specimen and eggs had been collected at Fort McPherson.

Gray-cheeked Thrush *Catharus minimus*

The gray-cheeked thrush breeds in forests, and on low arctic tundra near tree line, in northeastern Siberia and northern North America. In the Western Hemisphere it winters from southern Mexico and the West Indies south to northwestern South America. This species commonly nests in the forested part of the Delta Region and occasionally in tall shrubs on the tundra.

Wheatear *Oenanthe oenanthe*

The wheatear breeds on open tundra in northwestern North America and the eastern Canadian Arctic, and throughout Eurasia. North American populations winter in the Eastern Hemisphere. In the Delta Region, this species nests in the Richardson Mountains west of the Mackenzie Delta and has been seen occasionally on the Yukon North Slope, where it was recorded nesting at Cache Creek. East of the Mackenzie River it has been observed in the Anderson River Delta.

Bluethroat *Luscinia svecica*

The bluethroat breeds throughout Eurasia and northwestern Alaska, and winters from Africa to southeastern Asia. This species has been reported only once from the Delta Region; one was seen on the Babbage River in June 1973.

Ruby-crowned Kinglet *Regulus calendula*

The ruby-crowned kinglet breeds in coniferous woodlands from northern North America to central Arizona and New Mexico and northern Maine. It winters from its southern breeding range to Guatemala and Florida. This species has been reported only three times from the Delta Region: Preble saw one near Little Chicago in June 1904, Godfrey collected one at Mt.

Goodenough in August 1958, and one was seen north of Travaillant Lake in the summer of 1974.

Yellow Wagtail *Motacilla flava*

The yellow wagtail breeds throughout northwestern North America and Eurasia, and winters from Africa to southeastern Asia and the East Indies. In the Delta Region this species has been reported from the Yukon North Slope and from Richards Island. It was found nesting on the Babbage River in June 1972, and four fledglings were seen near the Big Fish River in July 1971. A pair was seen near Tununuk Point in June and July 1979 and was suspected to be nesting.

Water Pipit *Anthus spinoletta*

The water pipit breeds on low to mid-arctic and alpine tundra in Eurasia and North America to northern Arizona and New Mexico in the Rocky Mountains. In the Western Hemisphere it winters from the United States south to Guatemala. This species commonly nests in some locations on the tundra of the Delta Region. It has also been reported to nest near Fort McPherson and Fort Anderson.

Red-throated Pipit *Anthus cervinus*

The red-throated pipit breeds on the tundra of northern Eurasia and winters from northern Africa to southern China. There is one breeding record and some sight records of this bird from western coastal Alaska. A bird answering the description of this species was seen briefly on the Babbage River in June 1973; there is no previous record of its occurrence in Canada.

Bohemian Waxwing *Bombycilla garrulus*

The bohemian waxwing breeds widely in Eurasia and northwestern North America. In the Western Hemisphere it winters from the southern part of its breeding range south to California and Texas. This species occasionally nests in the forested part of the Delta Region, and has been seen only rarely in tundra areas.

Northern Shrike *Lanius excubitor*

The northern shrike breeds in Eurasia, northern Africa, and northern North America. In the Western Hemisphere it winters south to central Arizona and Maryland. This species nests

occasionally in the forested part of the Delta Region and has been seen only rarely north of tree line.

Starling *Sturnus vulgaris*

The starling formerly bred only in Eurasia, south of the tundra. The species was introduced into New York City in 1890 and now breeds across southern Canada and most of the United States. Northern populations are probably migratory. This species has been reported only once from the Delta Region; five were seen in the Anderson River Delta in May 1963.

Solitary Vireo *Vireo solitarius*

The solitary vireo breeds in woodlands across southern Canada and northern United States, extending south in the mountains to Central America; it winters from southern United States southward to Nicaragua and Cuba. This species has been reported only once from the Delta Region; one was seen on the Yukon coastal plain in September 1973.

Tennessee Warbler *Vermivora peregrina*

The Tennessee warbler breeds in woodlands across Canada and in northeastern United States, and winters from southern Mexico and Guatemala to Columbia and Venezuela. This species has been reported only twice from the Delta Region; one was heard singing at Aklavik in July 1942 and one was seen near Travaillant Lake in 1973.

Orange-crowned Warbler *Vermivora celata*

The orange-crowned warbler breeds in woodlands across northern North America, south to Baja California and western Texas. It winters from the southern United States to Guatemala and southern Florida. This species nests occasionally in the forested part of the Delta Region. It has been reported nesting at Fort McPherson and Anderson River, and has been seen in the foothills west of Aklavik, at Aklavik, in the upper East and Peel channels, and near Travaillant Lake.

Yellow Warbler *Dendroica petechia*

The yellow warbler breeds from near tree line across northern North America to northern South America, and winters from Mexico and the Bahamas south to Peru and Brazil. This species commonly nests in the forested part of the Delta Region and occasionally on the tundra.

Yellow-rumped Warbler *Dendroica coronata*

The yellow-rumped warbler breeds from near tree line in northern North America to the southwestern and northeastern United States. It winters from the northern United States south to central Panama and the Greater Antilles. This species commonly nests in some locations in the forested part of the Delta Region, and has been seen only rarely on the tundra.

Blackpoll Warbler *Dendroica striata*

The blackpoll warbler breeds in northern coniferous forests across northern North America south through the Maritimes and New England. It winters from Columbia to eastern Peru, western Brazil, and Chile. This species commonly nests in the forested part of the Delta Region and only rarely on the tundra.

Palm Warbler *Dendroica palmarum*

The palm warbler breeds from northern Alberta and western Mackenzie east to Newfoundland and south to the northeastern United States. It winters from the southeastern United States to Central America and the West Indies. It has been reported only once from the Delta Region, southwest of Aklavik in the summer of 1974.

Northern Waterthrush *Seiurus noveboracensis*

The northern waterthrush breeds in woodlands from Alaska and northern Canada to the northern United States, and winters from Mexico, Cuba, and the Bahamas to northern South America. This species occasionally nests in the Mackenzie Delta, adjacent uplands, and in the mountains near Lapierre House. It has been seen at the Babbage River and at Cache Creek, but nesting was not confirmed.

Wilson's Warbler *Wilsonia pusilla*

Wilson's warbler breeds in forests from Alaska and northern Canada to northern New Mexico and northern New England, and winters from northern Mexico and southern Texas to Costa Rica and western Panama. This species occasionally nests in the forested part of the Delta Region and has been seen only rarely on the tundra.

Red-winged Blackbird *Agelaius phoeniceus*

The red-winged blackbird breeds from southern Yukon and southwestern Newfoundland, south to Costa Rica and Cuba. It winters within the southern part of its breeding range. This

species has been reported only twice from the Delta Region; one was observed east of Fort McPherson in June 1971, and one was seen on Richards Island in the summer of 1974.

Rusty Blackbird *Euphagus carolinus*

The rusty blackbird breeds in woodlands from Alaska and northern Canada south to central British Columbia, central Manitoba, and northern New England. It winters from southern Canada to the southern United States. This species commonly nests throughout the forested part of the Delta Region and occasionally on the tundra.

Brewer's Blackbird *Euphagus cyanocephalus*

Brewer's blackbird breeds from southwestern Canada south to Baja California, northern Texas, and northern Iowa. It winters from its breeding range to southern Mexico and the Gulf Coast. This species has been reported only once from the Delta Region, east of Fort McPherson in June 1971.

Pine Grosbeak *Pinicola enucleator*

The pine grosbeak breeds in coniferous forests in northern and western North America and northern Eurasia. It winters within its breeding range and irregularly farther south. This species is an uncommon year round resident in the forested part of the Delta Region.

Hoary Redpoll *Acanthis hornemanni*

The hoary redpoll breeds on arctic tundra in northern circumpolar regions and winters from its breeding range south to the northern United States. This species commonly nests throughout the forest and tundra of the Delta Region, and sometimes overwinters in forested areas.

Common Redpoll *Acanthis flammea*

The common redpoll breeds in northern forests and on low arctic tundra in northern circumpolar regions. It winters from its southern breeding range to northern California, Kansas, and South Carolina. This species commonly nests throughout the forest and tundra of the Delta Region.

Red Crossbill *Loxia curvirostra*

The red crossbill breeds and overwinters in Eurasia, south to northern Africa, China, and the Philippines, and in North America in coniferous forests south to northern Nicaragua and North Carolina. It wanders widely throughout its range. This species has not been reported from the Delta Region since MacFarlane observed several birds at Fort Anderson in June 1862.

White-winged Crossbill *Loxia leucoptera*

The white-winged crossbill is a year round resident in northern coniferous forests in North America and Eurasia and in Hispaniola. This species is an uncommon resident of the forested part of the Delta Region; specimens have been collected at Aklavik and Fort Anderson.

Savannah Sparrow *Passerculus sandwichensis*

The savannah sparrow nests in open areas from the low arctic tundra of North America south to Guatemala and West Virginia, and winters from southern Canada south within its breeding range. This species commonly nests on tundra throughout the Delta Region, and in open sedge meadows in forested areas.

Vesper Sparrow *Pooecetes gramineus*

The vesper sparrow breeds from central British Columbia north to Great Slave Lake and across Canada to Nova Scotia and south to the southern United States. It winters in the southern part of its breeding range south to Florida, the Gulf Coast and southern Mexico. There is one report of a vesper sparrow from the Delta Region; one was seen at Moose Channel in August 1972.

Dark-eyed Junco *Junco hyemalis*

The dark-eyed junco breeds throughout woodlands from tree line in North America south through Baja California and northern Georgia, and winters from southern Canada to Mexico and the southern United States. This species occasionally nests in the forested part of the Delta Region, and has been observed only rarely on the tundra.

Tree Sparrow *Spizella arborea*

The tree sparrow breeds in northern forests and on low arctic tundra in Alaska and Canada, and winters from southern Canada to California and North Carolina. This species commonly nests throughout the forest and tundra of the Delta Region.

Chipping Sparrow *Spizella passerina*

The chipping sparrow breeds in woodlands throughout most of North America south to Nicaragua. It winters from southwestern and central United States south within its breeding range. This species has been reported rarely from the Delta Region; in July 1970 one was seen at Tuktoyaktuk and two more were seen at Toker Point; one was seen near Travaillant Lake in 1973, and north of Fort Good Hope in 1974.

Harris's Sparrow *Zonotrichia querula*

Harris's sparrow breeds in the forest-tundra ecotone from northwestern Mackenzie District through northern Manitoba, and winters from southern British Columbia and northern Nebraska and Tennessee to southern California and Texas. In the Delta Region this species commonly nests in the forest-tundra transition zone in and east of the Mackenzie Delta; it has been observed only rarely on the tundra. This species may have moved into the Delta Region within the last hundred years since MacFarlane did not record its presence in the 1860's.

White-crowned Sparrow *Zonotrichia leucophrys*

The white-crowned sparrow breeds on low arctic tundra and in northern coniferous forests in North America, south in the western United States to northern New Mexico. It winters from southern British Columbia, Kansas, and western North Carolina to Mexico and Cuba. This species commonly nests in the forested part of the Delta Region and occasionally nests on tundra.

Fox Sparrow *Passerella iliaca*

The fox sparrow breeds in northern forests across North America, south in the western United States to southern California. It winters from southern Canada to the southern United States. This species commonly nests in the forested part of the Delta Region and occasionally nests on the tundra.

Lincoln's Sparrow *Melospiza lincolnii*

Lincoln's sparrow breeds in bogs and meadows from Alaska to Labrador and south in western North America to southern California and in the east to northern New York and Maine. It winters from the southern United States to Guatemala and El Salvador. This species has been reported only rarely from the Delta Region: at Inuvik in June 1971, at two sites near Travaillant

Lake in 1973, and south of Fort McPherson and north of Fort Good Hope in 1974.

Lapland Longspur *Calcarius lapponicus*

The lapland longspur breeds on tundra in northern circumpolar regions. In the Western Hemisphere it winters from southern Canada to northern New Mexico, Louisiana and Virginia. This species is abundant on the tundra of the Delta Region.

Smith's Longspur *Calcarius pictus*

Smith's longspur breeds on low arctic tundra from northern Alaska to northern Ontario, and winters from Kansas and Iowa south to Texas and Alabama. This species occasionally nests on the tundra of the Delta Region. It has been recorded from Herschel Island to the lower Anderson River, and was observed nesting on Richards Island in 1974.

Snow Bunting *Plectrophenax nivalis*

The snow bunting breeds on arctic tundra in northern circumpolar regions. In the Western Hemisphere it winters from southern Alaska and southern Canada south to Oregon, northern New Mexico, Kansas, and Virginia. This species commonly migrates through the Delta Region, and occasionally nests along the coast and on offshore islands. Porsild noted that some birds may remain in the Delta Region during mild winters.

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5. AMPHIBIANS OF THE MACKENZIE DELTA REGION

5.1 Introduction

Few amphibians are found in the far North, and only one frog has been recorded from the Delta Region.

5.2 Annotated List of Species

ANURA Frogs and Toads

Wood Frog *Rana sylvatica*

The wood frog is found from Alaska and northwestern Mackenzie District south through Canada and the northeastern United States. In the Delta Region it is known only from near the inlet to Travaillant Lake where a number of young adults were collected 29 September 1974.

The Delta region is at the northern limit of the wood frog's range. Wood frogs mate in the spring when melting snow forms large pools of water. Eggs are laid in large globular masses and are attached to emergent vegetation below the surface of the water. The eggs probably hatch in late June or early July in the Delta Region and the tadpoles metamorphose into adults in late September. The young frogs are about 16–18 mm (2/3 in.) long, and adults are up to about 76 mm (3 in.) long. In northern parts of the wood frog's range, metamorphosis may not occur in the summer of birth if weather conditions are unfavourable.

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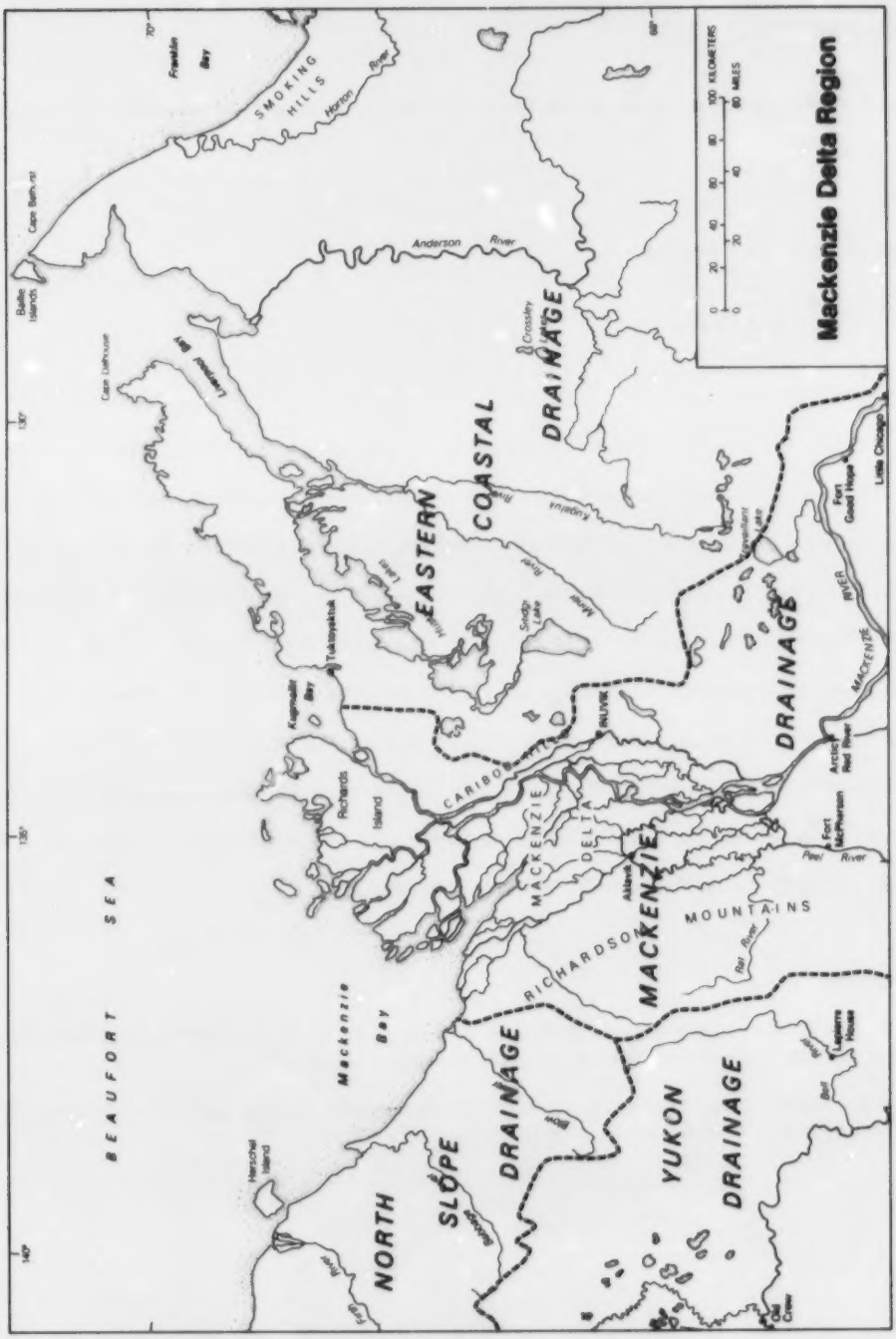
Figure 16. Drainage basins in the Delta Region.



6. FISHES OF THE MACKENZIE DELTA REGION

6.1 Introduction

The Delta Region includes parts of the Yukon, North Slope, Mackenzie, and Eastern Coastal Drainage systems (Figure 16), as well as the coastal waters of the southeastern Beaufort Sea from Herschel Island to Franklin Bay. Within the four drainage systems are populations or age classes of both migratory and relatively sedentary fish. Coastal waters contain marine fish and populations or age classes of species that migrate into freshwater to spawn (anadromous species).

The Delta Region, and in particular the Mackenzie Delta and lower Mackenzie River, has long been an important area for domestic, and to some extent, commercial fishing. However, little was known of the distribution and biology of most species in the Region until studies were initiated in response to the proposed Mackenzie Valley gas pipeline and to offshore drilling in the Beaufort Sea. Accordingly, most of the available data has been collected from areas where conflict might be expected. Locations of some spawning, rearing (nursery), and overwintering sites and migration routes have been described in reports of these studies in the Arctic Gas Biolcgical Report Series, the Environmental-Social Committee Northern Pipelines Task Force on Northern Oil Development series and the Beaufort Sea Project Technical Reports. Important areas for some species of fish have also been compiled in the Department of Environment's Land Use Information Series of maps. Little information is available on predator-prey and food chain relationships and factors limiting populations of fish in the Delta Region.

A total of fifty-five species of fish are known to occur in the Delta Region; six others have been reported, but their occurrence has not been confirmed. Of these sixty-one species, twenty-three are exclusively marine, twenty-one are exclusively freshwater, and seventeen are anadromous. All fish species in the Region are discussed in an annotated species list. Nomenclature is based mainly on references by Bailey *et al.* and by Legendre *et al.* Although some species of fish in the Delta Region are relatively sedentary, others undertake seasonal migrations which may be either fairly local or cover long distances. Movements of northern pike, Arctic and least cisco, lake and broad whitefish, inconnu, Arctic grayling, Arctic char and burbot are discussed in descriptions of some aspects of the biology of those species. General changes in the composition of fish species caught at Aklavik, Arctic Red River and the Rat River,

reflect seasonal movements (Figures 17–19). Of these, the annual runs of Arctic cisco and least cisco at Arctic Red River and Arctic char in the Rat River, are the most conspicuous.

The age of a fish can be determined by counting the number of annual bands on either scales or otoliths (part of the inner ear). Accurate estimates of age can be made from scale characteristics when growth rate is rapid, and they are reliable for species which continue to grow throughout their lives such as northern pike, lake and broad whitefish, inconnu and burbot. Aging from scale characteristics tends to give underestimates of the age of older individuals of species in which growth rate slows with age, since the annual bands on the scales become too narrow to read accurately. The bands on otoliths, however, can be distinguished more readily and provide a more accurate indication of age.

6.2 Northern Pike

Introduction

The northern pike or jackfish (*Esox lucius*) spawns in the spring and is primarily a freshwater fish, inhabiting the warm water of shallow lakes and bays or quiet rivers. In the Mackenzie River system the highest numbers of pike have been caught in shallow weedy areas and slow waters of back eddies or river mouths.

In the Delta Region this species occurs throughout the Yukon Drainage, in the North Slope Drainage west at least to the Babbage River, and throughout the Mackenzie Drainage and probably most of the Eastern Coastal Drainage. It has been reported in brackish coastal waters near the mouths of rivers off Tuktoyaktuk and Richards Island.

Movements

The northern pike is a relatively sedentary fish; tag returns from Aklavik and Arctic Red River areas indicate only minor movements during summer. The majority of recaptures in the Aklavik area were within 14 km (9 mi) of the release point, and the maximum distance recorded was 77 km (48 mi) for a fish tagged at Arctic Red River in 1973. After breakup in the spring, pike move into flooded areas and shallow lakes and creeks for spawning. Post-spawning populations remain in shallow warm waters over summer, although in some areas in the Delta declining water levels following spring flooding may cause pike to disperse into the deeper waters of the Mackenzie River. Between mid-August and freeze-up, pike move out of shallow

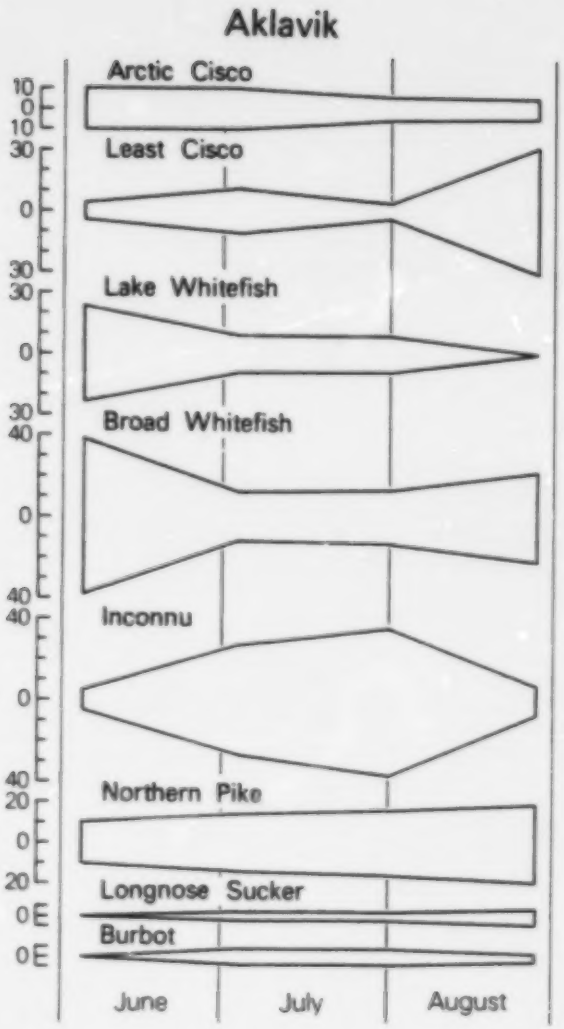


Figure 17. Percent Composition of Catch at Aklavik, June–August 1972 (after Stein *et al.* 1973a,b).

waters and during November and December often concentrate at the mouths of creeks. They require deep channels and lakes for overwintering.

Reproduction

Pike become sexually mature at three to seven years; males usually become mature one to two years before females. In the Mackenzie River, minimum age at maturity was found to be four years for females and three years for males; in lakes on Richards Island, the minimum age

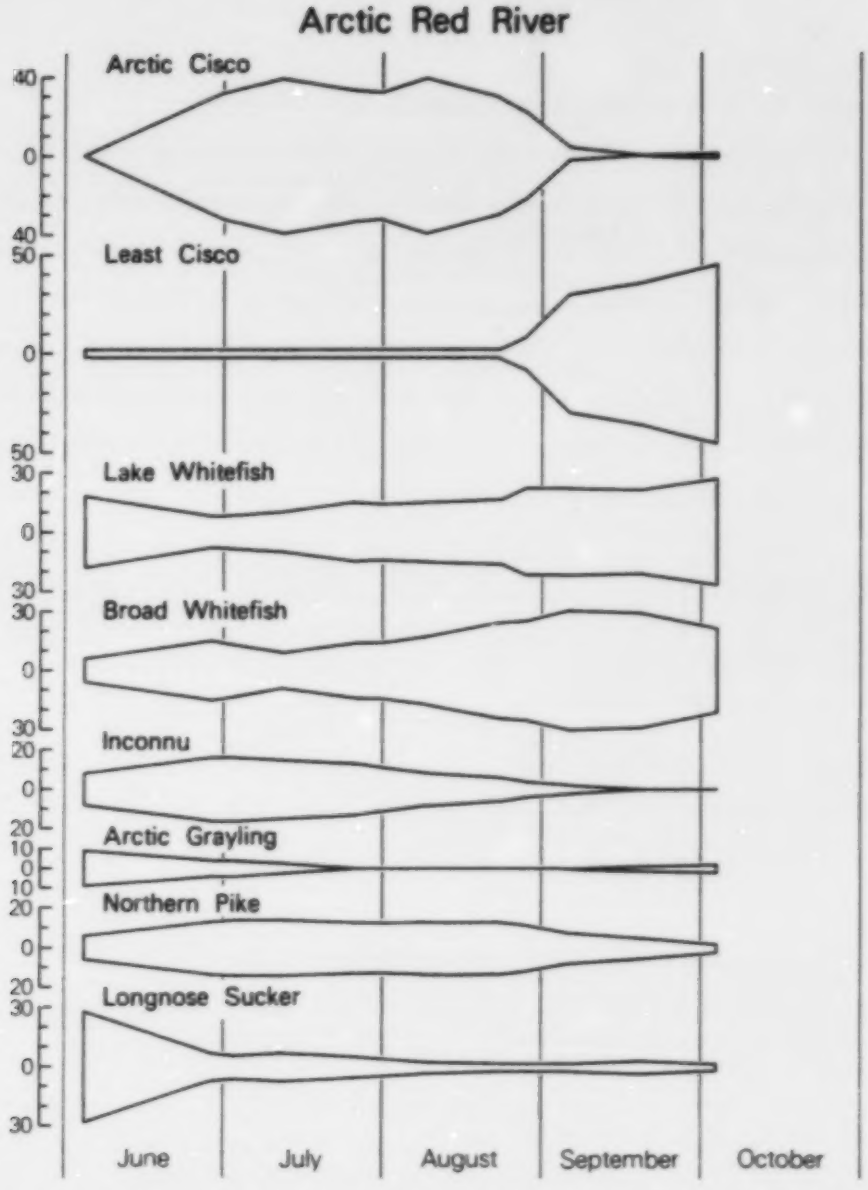


Figure 18. Percent Composition of Catch at Arctic Red River, June–October 1971 and 1972 (after Hatfield *et al*. 1972a,b; Stein *et al*. 1973a,b).

was three to four years, while in the outer Delta the minimum age was seven years.

In the Delta Region, pike spawn from about mid-June to early July following ice breakup. Unlike other fish species they require spawning substrates of flooded vegetation. Eggs adhere to plants and when the young (fry) emerge after about two weeks they remain attached to the plants while feeding from the egg yolk. A fairly high degree of siltation is tolerated, but heavy siltation, exposure of plants from declining water levels, predation and cannibalism may result in high mortality. Much of the Mackenzie Delta is an important nursery area for fry.

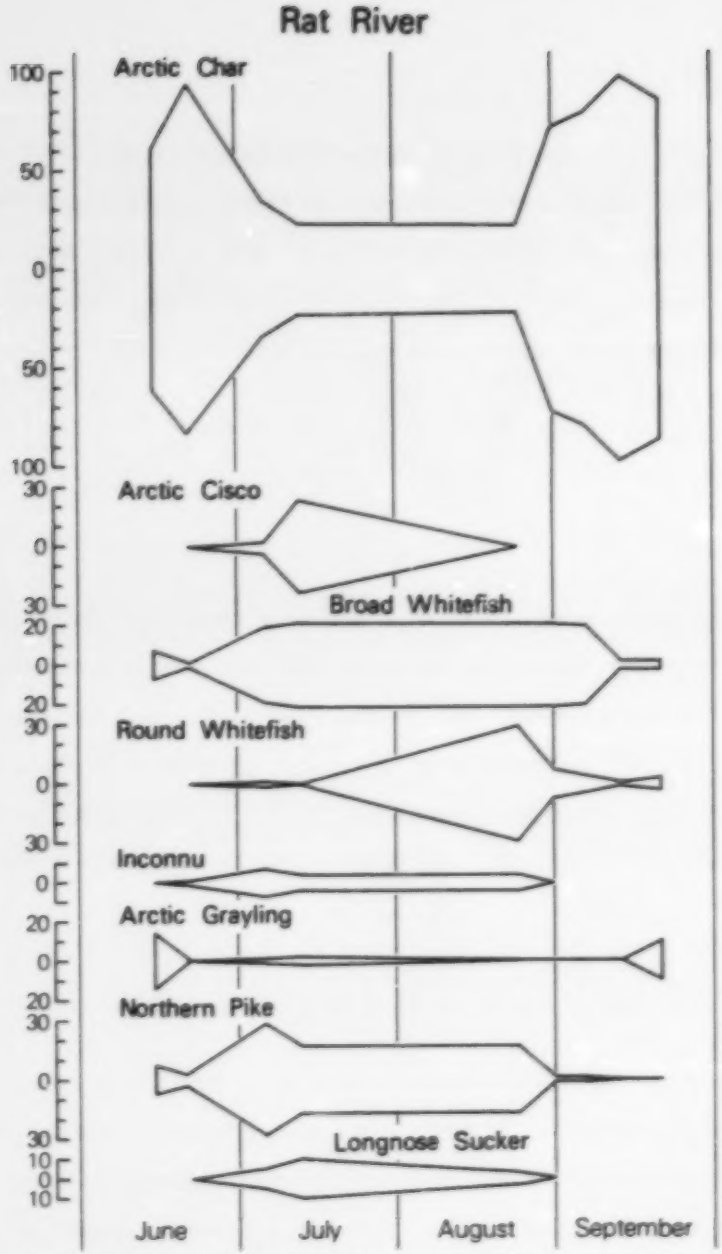


Figure 19. Percent Composition of Catch on the Lower Rat River, June–September 1972 (after Jessop *et al.* 1973).

Food Habits

Northern pike fry feed on zooplankton and aquatic insects. Mature pike feed mainly on fish, including small individuals of their own species. Small mammals and invertebrates are also taken. The range of prey species is wide and includes whitefish, cisco, pond smelt, burbot, stickleback, trout-perch, walleye and sculpin.

Growth and Age

Age-length data for northern pike from the Delta Region are shown in Figure 20. Northern pike grow very rapidly, and growth in the Delta Region is more rapid than that reported from more southern populations in the Great and Lesser Slave lakes, Lake Athabasca, Great Bear Lake and Waskesiu Lake. The oldest northern pike recorded from the Delta Region was estimated to be nineteen years and was taken from the Aklavik area and the longest was 980 mm (39 in) and was taken from the Rat River.

6.3 Arctic Cisco

Introduction

The Arctic cisco *(Coregonus autumnalis)* is an anadromous fish which spawns in the fall; it occurs in the Colville River, Alaska, the Mackenzie River, and in the coastal waters of the southeastern Beaufort Sea, often near river mouths This species has a high tolerance for salinity and appears to spend more time at sea than other whitefish. In the Delta Region, Arctic cisco are found in coastal waters, throughout the Mackenzie Drainage, and in lower parts of the Eastern Coastal Drainage. In the North Slope Drainage, it is found primarily in brackish coastal waters and lagoons and seldom ventures farther than 1 km (about 1,000 yards) up deltas of large rivers.

Movements

Arctic cisco migrate up the Mackenzie River to spawning grounds in late summer and early fall, and return downstream in October. In late June, Arctic cisco are abundant in catches in the lower Delta and coastal regions, and upstream movements may begin as early as July. Many Arctic cisco are found in the Arctic Red River area from late June to August, but by the end of August they leave the area (Figure 18); cisco may gather in the Arctic Red River area prior to the upstream spawning run. Runs peak at Arctic Red River in the first two weeks of August; they peak at the mouth of the Peel River in late August, and farther upstream in mid-September. By September, Arctic cisco are absent from the mainstream of the Mackenzie River, and are believed to spawn in tributaries at this time. They are also known to spawn in the Colville River, Alaska. Downstream post-spawning runs occur in October in the Arctic Red River, Peel River, Peel Channel and West Channel. Older juveniles and mature non-spawners move into coastal

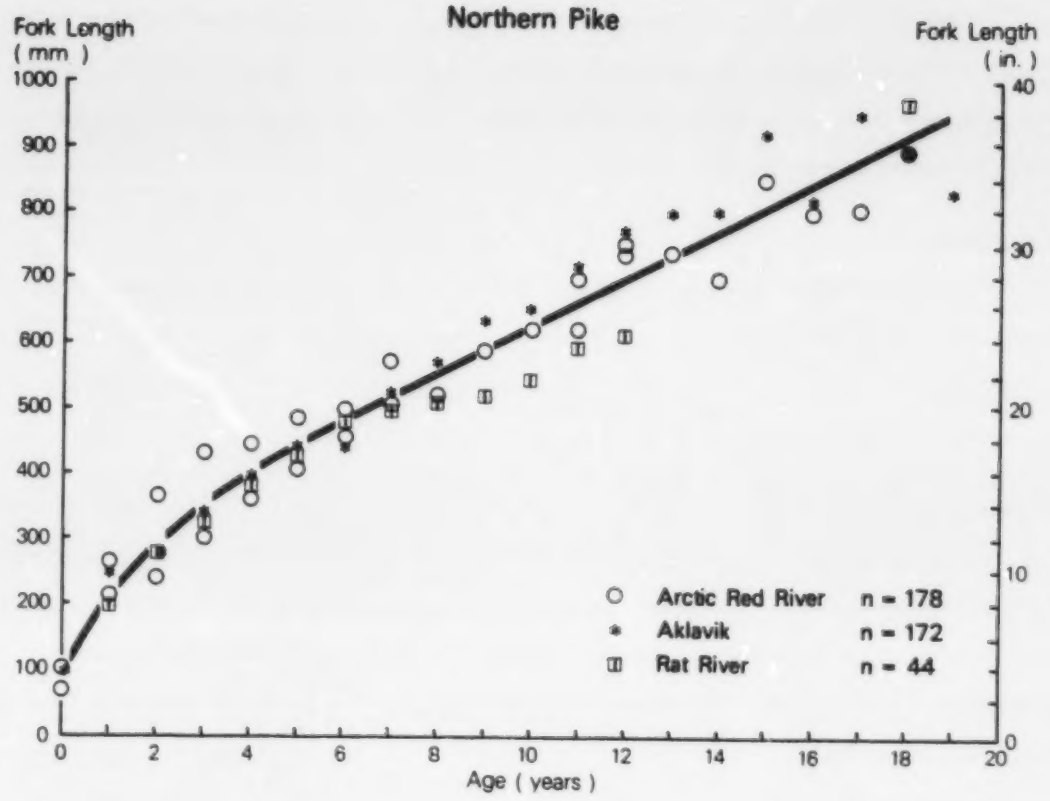


Figure 20. Growth Curve for Northern Pike in the Delta Region.

waters for the summer. Arctic cisco overwinter in the Mackenzie Delta.

Reproduction

In the Delta Region, Arctic cisco appear to become sexually mature between the ages of seven and nine years, but females probably only spawn in alternate years, or possibly every third year. Spawning runs in the Mackenzie River system are much longer and take place about two months earlier than those in the Colville River system west of the Delta Region. Spawning areas are not well known, but gravel substrates in clear waters are required, and mountain tributaries of the Peel, Arctic and Red rivers are believed to be used. Spawning probably takes place in September in the Delta Region.

Eggs overwinter and fry emerge in the spring and move downstream with the spring floods to nursery areas in the Delta. Major nursery areas are in channels, lakes and streams of the upper and lower Delta and in some tributaries of the Peel River. Fry tend to move into brackish waters as they become older.

Food Habits

In coastal waters of the southeastern Beaufort Sea, Arctic cisco feed mainly on zooplankton; in fresh water they feed on insects, insect larvae, fish and fish eggs. Prior to and during spawning runs adults appear to cease feeding. Juveniles feed primarily on insects, insect larvae and crustaceans.

Growth and Age

Age-length data for Arctic cisco in the Delta Region are shown in Figure 21. The growth rate is considerably lower than that reported for Arctic cisco in Siberia. The oldest specimen recorded from the Delta Region was estimated to be twenty-one years based on growth characteristics of otoliths. The longest individual was 510 mm (20 in) and was taken from the outer Mackenzie Delta.

6.4 Lake Whitefish

Introduction

The lake or humpback whitefish *(Coregonus clupeaformis)* spawns in the fall and inhabits lakes and large rivers, as well as brackish coastal waters. In the Delta Region it occurs in all drainage systems and along the coast from Stokes Point east to Atkinson Point. West of Kay Point, the lake whitefish is restricted to rivers, estuaries and lagoons.

Movements

In the Mackenzie Delta and southern Kugmallit Bay, lake whitefish are relatively sedentary throughout most of the summer, but by late summer or early fall an upstream pre-spawning migration run begins. In the Mackenzie Delta, the majority of lake whitefish probably migrate to Arctic Red River to spawn although some spawn in the upper Delta, Rat River, and the Travaillant Lake area. Lake whitefish move from coastal areas and the lower Delta along major channels from mid-August to early October. Concentrations of ripe individuals occur near Arctic

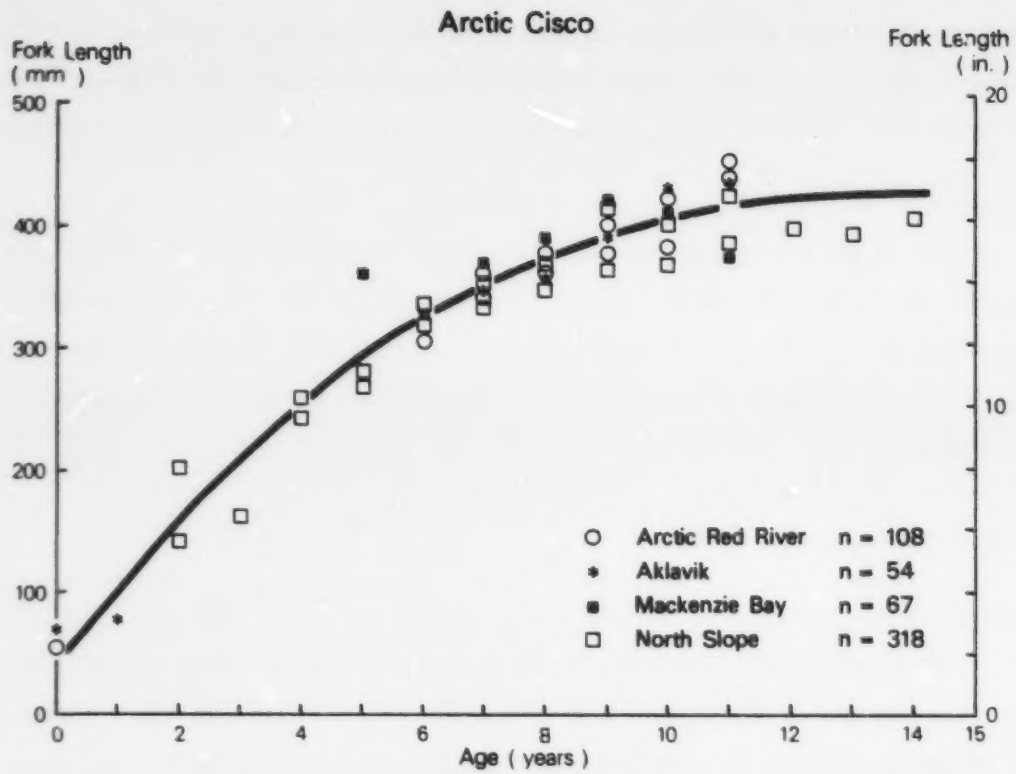


Figure 21. Growth Curve for Arctic Cisco in the Delta Region.

Red River in the first week of October (Figure 18), and by late October or early November downstream movements of spent fish from Arctic Red River pass Aklavik. Known overwintering areas include the lower Mackenzie Delta and Kugmallit Bay.

Reproduction

In the Delta Region the minimum age of the lake whitefish at sexual maturity is seven years for males and nine years for females; mature females appear to spawn only every second or third year. Fish spawn during October in shallow water usually over a gravelly substrate, but sometimes over sand. Eggs overwinter and fry emerge in early spring. Known nursery areas appear to be close to some spawning areas and comprise channels and back eddies in the lower Mackenzie River and Delta and in the Travaillant Lake area.

Food Habits

Young whitefish feed on insect larvae and other small invertebrates; larger invertebrates, ninespine sticklebacks and plant material are also included in the diet of adults. Lakes in the Mackenzie Delta are probably important feeding areas since relatively few fish taken from lakes had empty stomachs, in contrast to those taken in the Mackenzie River system above the Delta.

Growth

Age-length data for lake whitefish in the Delta Region are shown in Figure 22. Growth rates of lake whitefish are generally higher in the Delta Region than in the central and upper parts of the Mackenzie River, and are lowest in the southern parts of their range. The oldest fish caught in the Delta Region was estimated to be eighteen years and the longest specimen was 800 mm (32 in).

6.5 Broad Whitefish

Introduction

The broad whitefish *(Coregonus nasus)* spawns in fall and is primarily an inhabitant of rivers, but also occurs in lakes and in brackish coastal waters. In the Delta Region it is present in all drainage systems and along the coast from Herschel Island to Toker Point.

Movements

The seasonal movements of broad whitefish are very similar to those of lake whitefish. Summer movements are local; in late summer and early fall upstream migrations begin, and after spawning in late fall there is a return migration downstream. Upstream spawning migrations from the lower Delta and coastal regions begin in late August and peak in September and October. Spawning areas are located in the Mackenzie River from Horseshoe Bend in the upper Delta to Fort Good Hope, as well as in the lower Peel River. The mouth of the Arctic Red River is a major spawning area and broad whitefish are thought to migrate there from both upstream and downstream locations. From mid-October to early November broad whitefish are abundant near Arctic Red River, and numbers of fish caught have been highest in the first week of November. In the first two weeks of November a downstream, post-spawning migration begins, during which the most fish pass through Middle Channel, while some follow the

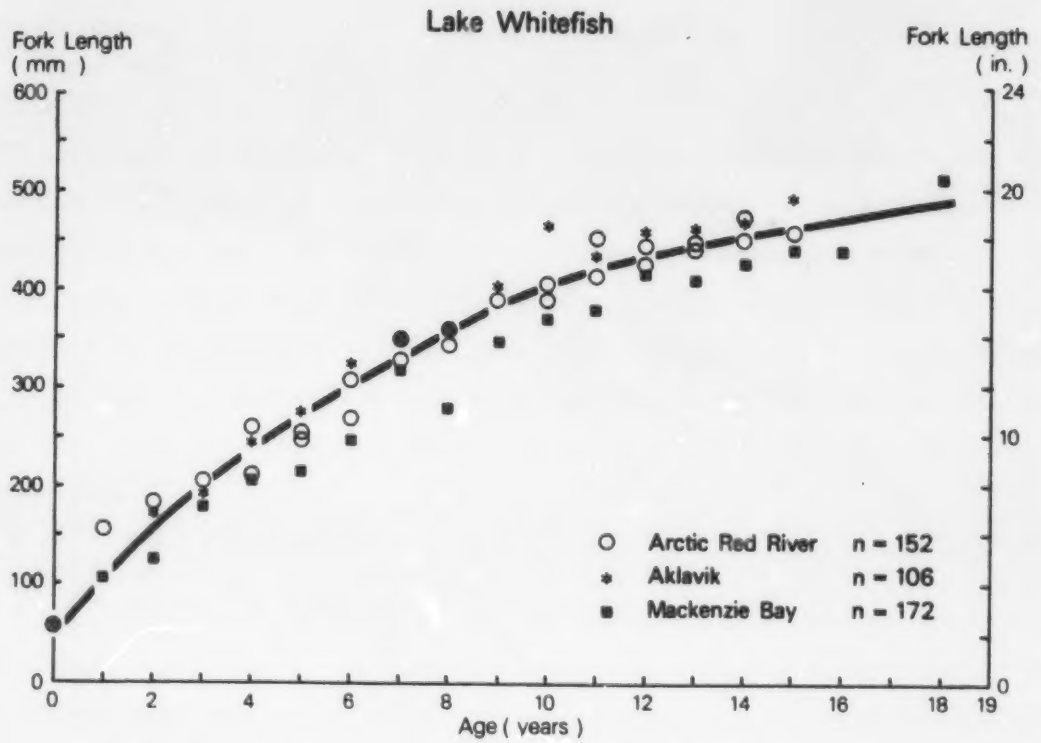


Figure 22. Growth Curve for Lake Whitefish in the Delta Region.

Aklavik and West Channels. In the upper Delta, Horseshoe Bend is a suspected spawning area because ripe broad whitefish have been captured there as late as November, but no spent fish have been caught. Upstream migrations in Rat River have also been recorded and are believed to be spawning migrations, although spawning areas are not known. Maximum catches on the lower Rat River occur in late August and September, but only a few of the fish that have been taken have been ripe. Broad whitefish overwinter in both the upper and lower Delta.

Reproduction

In the Mackenzie Delta broad whitefish become sexually mature between three and ten years of age; mature females may spawn only in alternate years. Tributaries and back eddies of rivers in the Mackenzie River system appear to be important spawning sites and spawning occurs in late October and early November. Fry emerge in spring, and back eddies of the Mackenzie River and small lakes in the Mackenzie Delta appear to be important nursery areas.

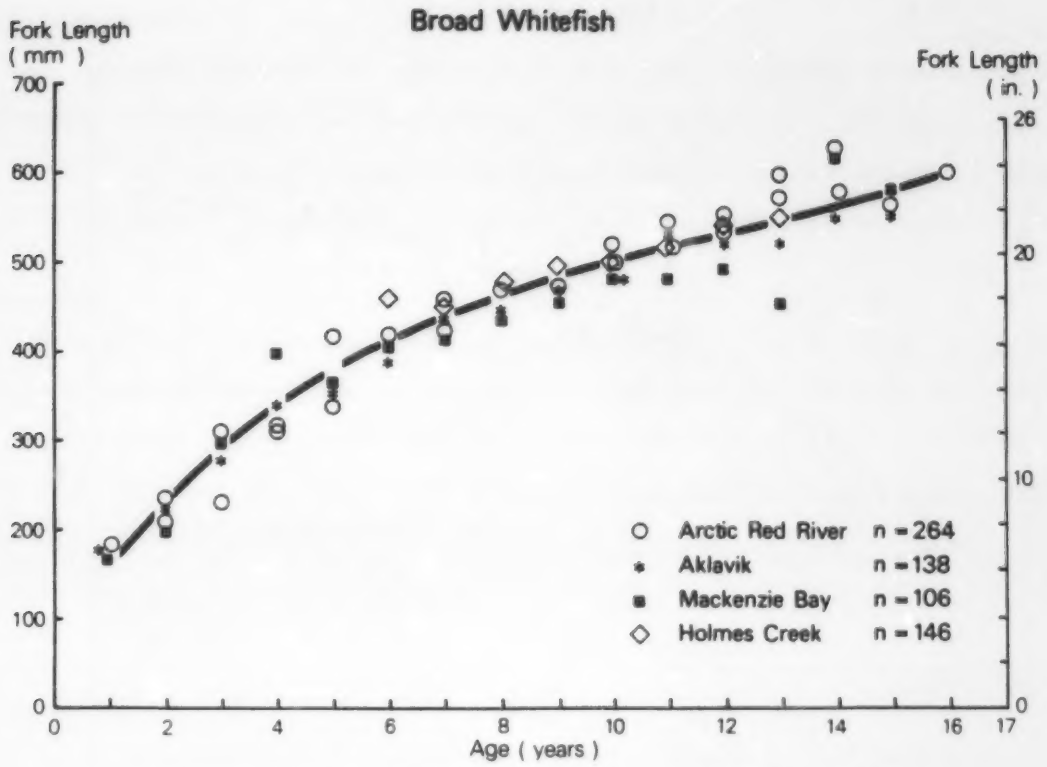


Figure 23. Growth Curve for Broad Whitefish in the Delta Region.

Food Habits

The food of broad whitefish and important feeding areas are essentially the same as those of lake whitefish.

Growth and Age

Age-length data for broad whitefish in the Delta Region are shown in Figure 23. Growth rates of these fish are much higher than those reported from fish at Norman Wells. The oldest fish caught at Arctic Red River, in the Delta Region, was estimated to be over sixteen years, and the longest specimen was 655 mm (26 in) and was taken from the outer Mackenzie Delta. Most of the fish caught in the upper Delta and Arctic Red River have been from eight to eleven years old, and only a small percentage has been under four years, while catches from the lower Mackenzie Delta have yielded a high proportion of young fish.

6.6 Least Cisco

Introduction

The least cisco *(Coregonus sardinella)* occurs in offshore waters, coastal regions, lakes and rivers. In the Delta Region, this species is present in all drainage systems and in coastal waters of the southeastern Beaufort Sea. Some populations are anadromous and others remain in fresh water lakes year-round. Anadromous least cisco summer in brackish and offshore waters and migrate up rivers in the fall to spawn. Freshwater least cisco may undertake limited seasonal movements within a lake system, or they may remain in the same lake throughout the year. There are "dwarf" and "normal" sized freshwater forms and both forms may be found in the same lake.

Movements

In general, anadromous least cisco move from offshore regions and coastal waters in late summer, pass through the Mackenzie Delta by late August, and ascend the Mackenzie River in early fall to spawn.

The numbers of fish caught are highest during the last two weeks of August at Aklavik, and in mid-October at Arctic Red River (Figures 17 and 18). Runs of ripe fish have been recorded in the Peel and Husky channels and in the Peel and Mackenzie rivers during late September and early October. It appears that some cisco migrate only as far as the Mackenzie Delta to spawn while others move farther upstream. Generally, spawning is thought to occur in the lower reaches of the Mackenzie and Peel rivers. Anadromous least cisco overwinter in coastal and estuarine waters, as well as in the Mackenzie Delta.

Little is known about movements of freshwater least cisco in the Delta Region. Some fish are thought to move into Peter Lake, in the Caribou Hills, to spawn; spawning also appears to take place in a lake on Richards Island.

Reproduction

In the Delta Region, both the anadromous and normal form of freshwater least cisco mature between five and seven years of age; the dwarf freshwater form may mature as early as three years of age. Anadromous fish spawn from mid-September to mid-October in alternate years; freshwater normal forms spawn from mid-September to after freeze-up, and dwarf forms spawn from early September to early October. Females spawn over gravel or sand

substrates and fry emerge the following spring before breakup. Anadromous fry move to brackish coastal and estuarine waters. Nursery areas for freshwater fry, in lakes on the North Slope, are characterized by an absence of rooted vegetation.

Food Habits

Least cisco appear to suspend feeding prior to and during spawning. Anadromous cisco in coastal waters appear to feed selectively on amphipods and other small crustaceans. In the Mackenzie Delta, stomachs of least cisco were found to contain a variety of small invertebrates and ninespine stickleback.

Growth and Age

Age-length data for anadromous and freshwater least cisco in the Delta Region are shown in Figures 24 and 25. Anadromous least cisco grow more rapidly than the freshwater forms; cisco taken from the Yukon coast and the Colville River, Alaska, appear to grow faster than those taken from the Mackenzie Estuary. However, differences in growth rates may be a reflection of different methods of estimating the age of fish. Normal form least cisco in the Delta Region show similar growth rates to freshwater least cisco near Point Barrow, Alaska. Dwarf form least cisco grow very little after reaching sexual maturity. The oldest anadromous least cisco recorded from the Yukon coast in the Delta Region was estimated to be thirteen years old; while the oldest freshwater least cisco of normal and dwarf forms were estimated to be twenty-five years and fourteen years respectively. The longest anadromous least cisco recorded from the Delta Region was 394 mm (16 in), and was taken near Aklavik; freshwater least cisco of normal form may grow up to 340 mm (13 in), while the dwarf form may only grow up to 154 mm (6 in).

6.7 Inconnu

Introduction

The inconnu or "conny" *(Stenodus leucichthys)* is anadromous in the lower Mackenzie River system, but in the upper Mackenzie drainage system inconnu remain in freshwater year round. Both anadromous and freshwater inconnu spawn in the fall. In the Delta Region the inconnu is present in the Yukon Drainage, in coastal lakes in the North Slope Drainage, throughout the Mackenzie Drainage, and east to the Anderson River in the Eastern Coastal Drainage. It also

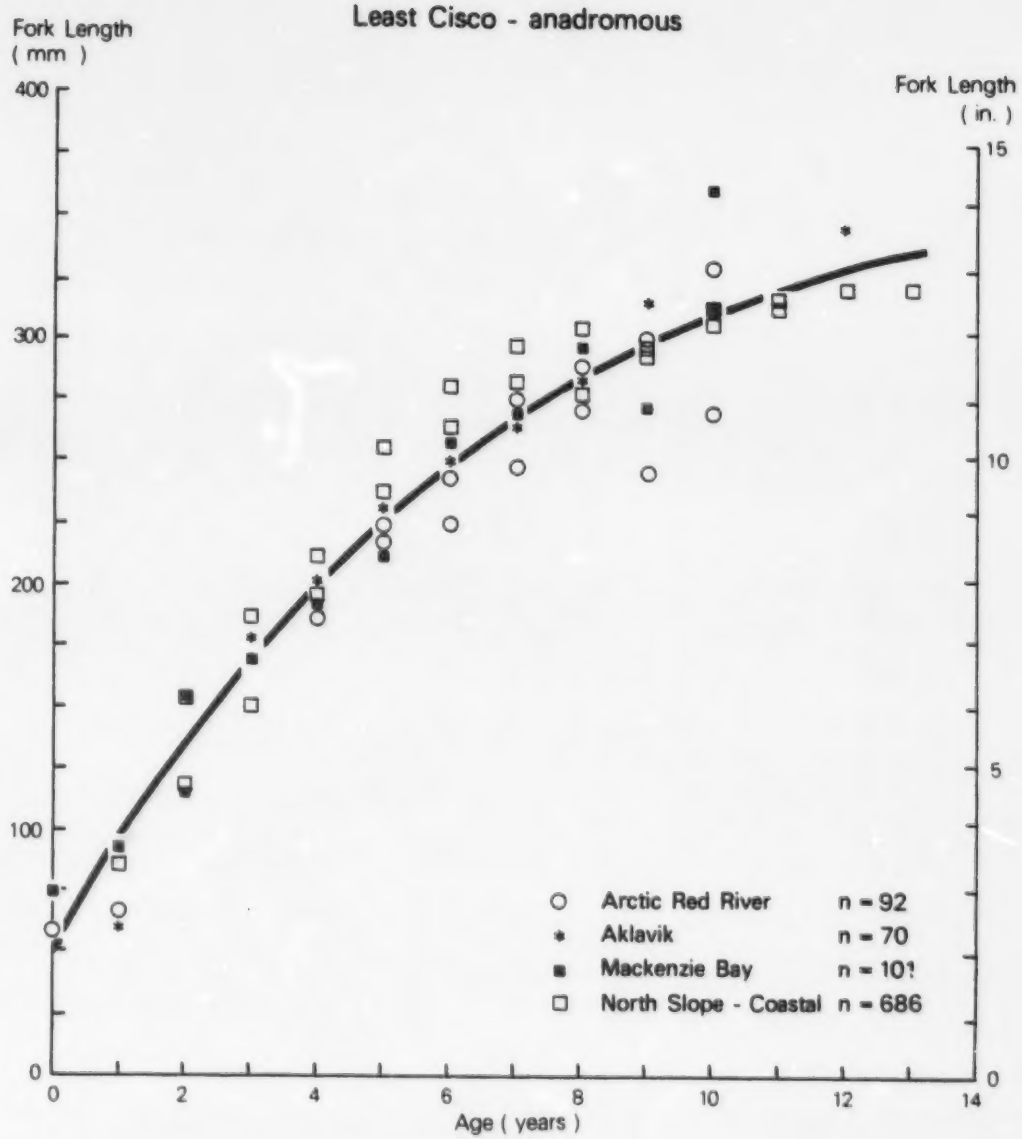


Figure 24. Growth Curve for Anadromous Least Cisco in the Delta Region.

occurs in coastal and estuarine waters of the Beaufort Sea from Herschel Island to the Tuktoyaktuk Peninsula.

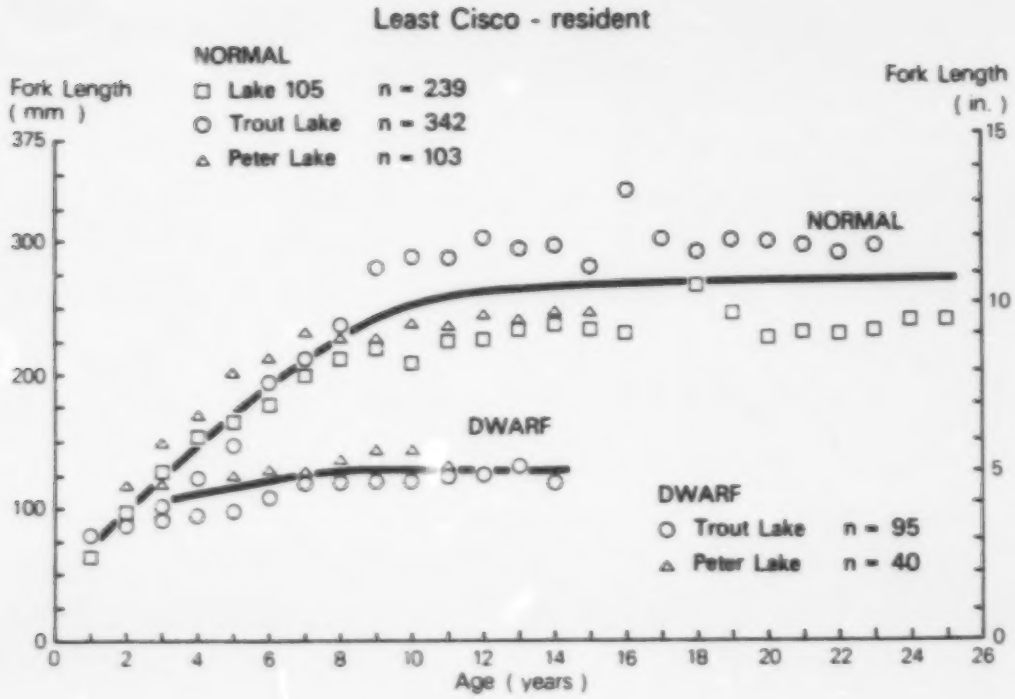


Figure 25 Growth Curve for Resident Least Cisco in the Delta Region.

Movements

In the Mackenzie River, inconnu make spawning migrations from July to September, and after spawning, move downstream in October and November. Inconnu migrate upstream through Mackenzie Delta channels and up the Mackenzie River as far as Fort Good Hope. They also migrate up the Peel and Arctic Red rivers. Spawning areas in the Delta Region are not known, but are suspected to be in tributaries to the Mackenzie, Peel and Arctic Red rivers. Immature inconnu apparently remain in the lower Mackenzie Delta and in coastal waters during summer. Inconnu probably overwinter in the lower Mackenzie Delta and Estuary. Nothing is known about movements of inconnu in lakes on the North Slope.

Reproduction

In the Delta Region inconnu become sexually mature between four and ten years of age. Minimum age at maturity varies according to estimates from several surveys in different areas.

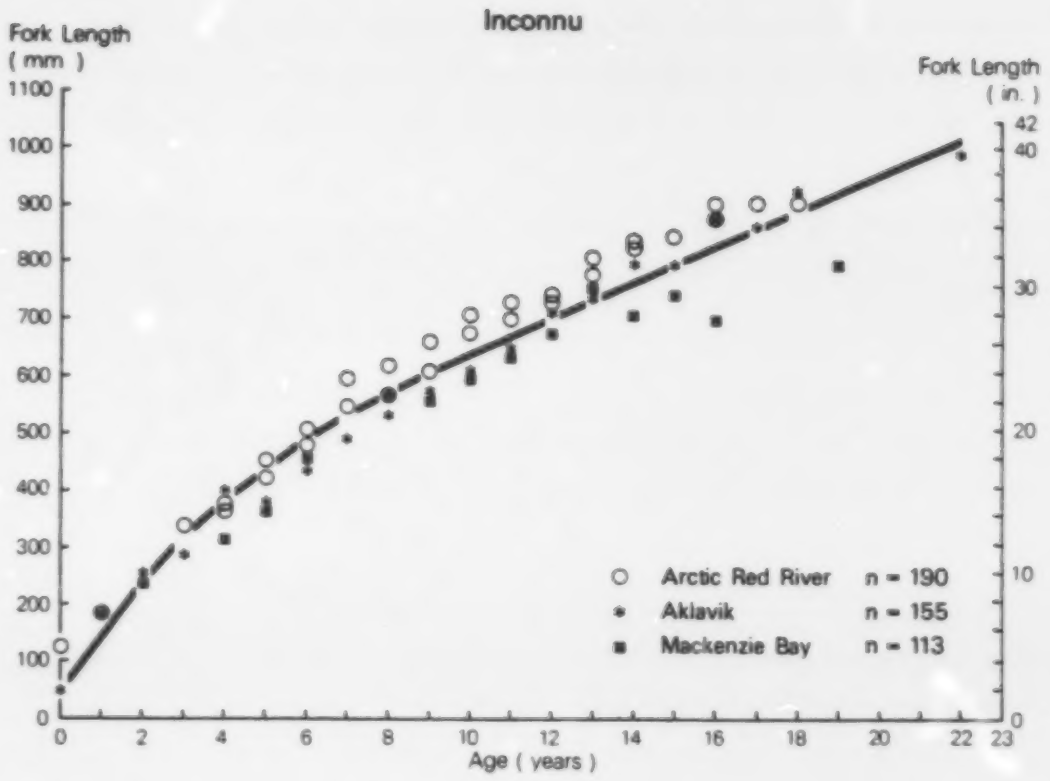


Figure 26. Growth Curve for Inconnu in the Delta Region.

Females reach maturity later than males and probably spawn only in alternate years or at even longer intervals. Spawning occurs in clear, fast-flowing waters over a gravel substrate. Eggs overwinter and fry emerge in the spring and are probably carried downstream with flood waters. However, nursery areas in the Region have not been identified.

Food Habits

Young inconnu feed primarily on aquatic insects and crustaceans while small fish constitute most of the diet of adult inconnu; particularly young whitefish, least and Arctic cisco, pond smelt, pike, sculpin, flounder and stickleback. Adults also take individuals of their own species.

Growth and Age

Age-length data for inconnu in the Delta Region are shown in Figure 26. Inconnu in the Delta Region of the Mackenzie Drainage are notably larger than those captured farther upstream

at Norman Wells and Fort Simpson, but not larger than inconnu taken from Great Slave Lake. In the Delta Region the oldest and longest inconnu was estimated to be twenty-two years old and was 987 mm (39 in) long; it was taken near Aklavik. Females appear to live longer than males.

6.8 Arctic Grayling

Introduction

The Arctic grayling *(Thymallus arcticus)* is common in lakes, rivers and streams in the North. It is widespread in the Delta Region, occurring in all the drainage systems, but is less common in brackish waters of estuaries along the Yukon coast, although it is reported to occur in Liverpool Bay. Unlike most species in the North, Arctic grayling spawn in spring.

Movements

The seasonal movements of Arctic grayling vary greatly among populations. There is a pre-spawning migration at breakup from overwintering areas in lakes and large rivers to tributaries, which may be followed by a movement back to the rivers and lakes immediately after spawning, or adults may remain in the tributaries until fall (Figures 17 and 18). In rivers in the North Slope drainage system juvenile grayling remain in overwintering areas all summer, while mature grayling appear to overwinter in Parsons Lake or the Eskimo Lakes and move only to the outflow of Parsons Lake in the spring. The grayling at Fish Hole, in a tributary to Big Fish River, appear to be a resident population. Fish tagged at Fish Hole showed no significant movements from one summer to the next or within one season.

Reproduction

Very little appears to be known of reproduction of Arctic grayling in the Delta Region. Grayling are believed to mature between four and seven years. It is not known whether mature individuals spawn in consecutive years or at longer intervals. Grayling spawn from late May to mid-June and throughout most of their range require clear water with high levels of dissolved oxygen and a gravel, silt-free substrate. However, in the North Slope drainage system grayling apparently spawn in turbid waters. Fry emerge after two to three weeks and nursery areas are often close to spawning areas.

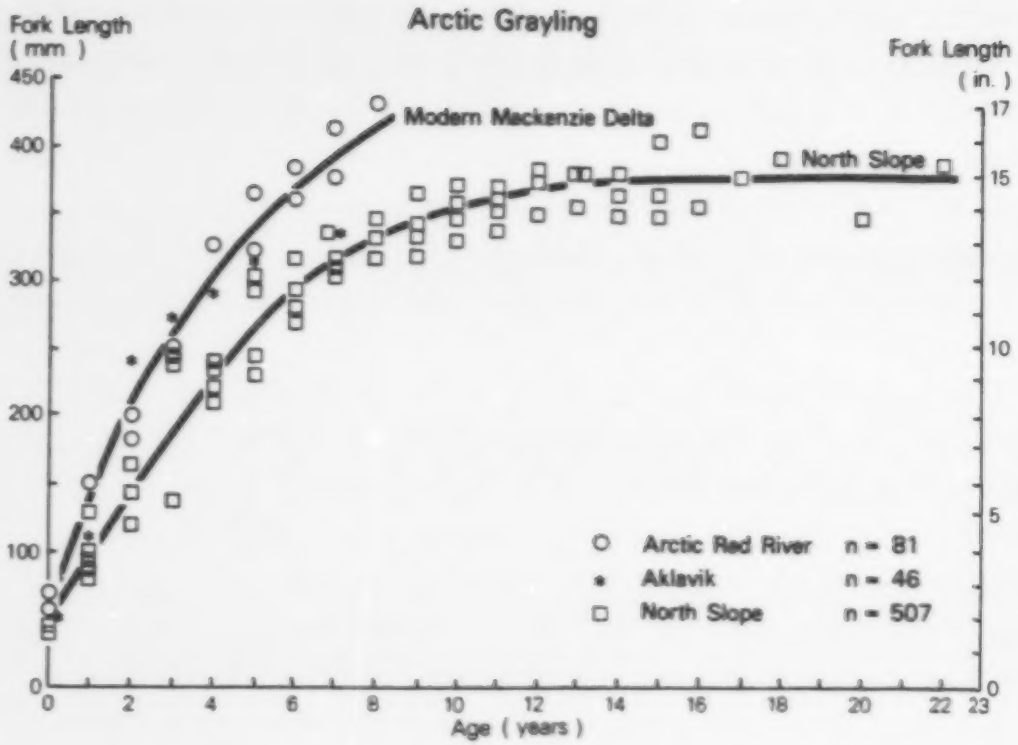

Arctic Grayling
Fork Length (mm)
Fork Length (in.)
Modern Mackenzie Delta
North Slope
Arctic Red River n = 81
Aklavik n = 46
North Slope n = 507
Age (years)

Figure 27. Growth Curve for Arctic Grayling in the Delta Region.

Food Habits

The Arctic grayling is an opportunistic feeder, although terrestrial and aquatic insects constitute the mainstay of its diet. Fry feed on insect larvae. Adult grayling are also known to take young individuals of their own species.

Growth

Age-length data for Arctic grayling in the Delta Region are shown in Figure 27. The growth rate of grayling from the Mackenzie Delta appears to be more rapid than that for populations in the North Slope Drainage. This difference is probably real, rather than being an artifact of the aging technique. The growth rate of grayling from the Mackenzie Delta is similar to that for populations in other parts of the Mackenzie River system. In the Mackenzie Delta

Region the oldest and longest grayling was estimated to be eight years old, was 433 mm (17 in) long, and was caught at Arctic Red River. In the North Slope Drainage the oldest grayling was estimated to be twenty-two years old, and the longest was 430 mm (17 in); both were taken from the Firth River.

6.9 Arctic Char

Introduction

There are two species of char in the North, *Salvelinus alpinus*, and *Salvelinus malma*. The latter is known as Dolly Varden, is not common or widespread in distribution, and its presence in the Delta Region has not been confirmed. Two forms (possibly species) of Arctic char (*Salvelinus alpinus*) have been described according to taxonomic and behavioural differences; these are the western arctic-Bering Sea form and the eastern arctic form. Both western and eastern forms occur in the Delta Region and may be either anadromous or non-anadromous. West of the Mackenzie River the eastern form is restricted to lakes in the North Slope drainage. In the following discussion of Arctic char no distinction will be made between western and eastern forms and populations will be referred to as anadromous and non-anadromous.

In the Delta Region, char are relatively abundant in the North Slope Drainage, fairly common throughout the Mackenzie Drainage, and less common in the Eastern Coast Drainage. Anadromous char occur in coastal waters throughout the Region. Arctic char spawn in the fall.

Movements

Anadromous char generally migrate into coastal waters following breakup. Some adults may remain in freshwater during the year in which they spawn, and some males older than five years may also remain in freshwater year round. Most juveniles between the ages of two and five years (smolts) migrate into coastal waters for the summer, but younger fish remain in freshwater systems.

Spawning adults return from coastal waters about a month earlier than non-spawners. Char enter the Mackenzie Delta in August, reach the mouth of the Big Fish River by mid-August and pass through the West, Peel, and Husky channels in August and September. They arrive at Fish Hole on the Big Fish River from September through mid-October, and their numbers peak

on the lower Rat River in mid-September (Figure 19). Char also gather along the Yukon coast, especially near Herschel Island, in August and September. Upstream migrations occur from late-July through September. Spawning grounds often occur within general overwintering areas, although the extent of the latter is not well-known. Char require deep, flowing water for overwintering. Tag returns indicate that many char return annually to Fish Hole to spawn and/or overwinter. Fish Creek, a tributary of the Rat River, is also an overwintering area, however, tag returns indicate a post-spawning downstream migration in the Rat River, presumably to other overwintering areas.

Non-anadromous land-locked char are often found in the North Slope drainage in association with warm springs. Movements are restricted by barriers, such as waterfalls, and populations are genetically isolated. Land-locked char disperse from overwintering areas after breakup and move to feeding and spawning areas. Fry and juveniles may be found in side channels over summer. At freeze-up, land-locked char return to deep pools or spring water sources to overwinter.

Reproduction

Non-anadromous lake-dwelling char mature earlier than anadromous char; minimum age for males at sexual maturity is two years and for females three to four years; minimum age for anadromous char at sexual maturity is four to five years in the Delta Region. Females spawn every second or third year, and anadromous females produce many more eggs than lake-dwelling females. Anadromous char usually spawn over gravel in fast flowing streams, or in shallow pools below rapids. Lake-dwelling char may spawn over rocky shoals in lakes or near springs. Eggs overwinter and fry emerge between late May and July and remain close to spawning areas during their first summer.

Food Habits

Anadromous char apparently feed very little while migrating, spawning or overwintering. During the three to four months of the year that they spend in coastal waters they feed on small crustaceans and fish, principally Arctic cod. Spawning char that do not migrate to the sea feed in freshwater. Their diet is similar to that of resident males, juveniles and fry, and consists mainly of immature forms of stream-dwelling benthic invertebrates. Adults remaining in the

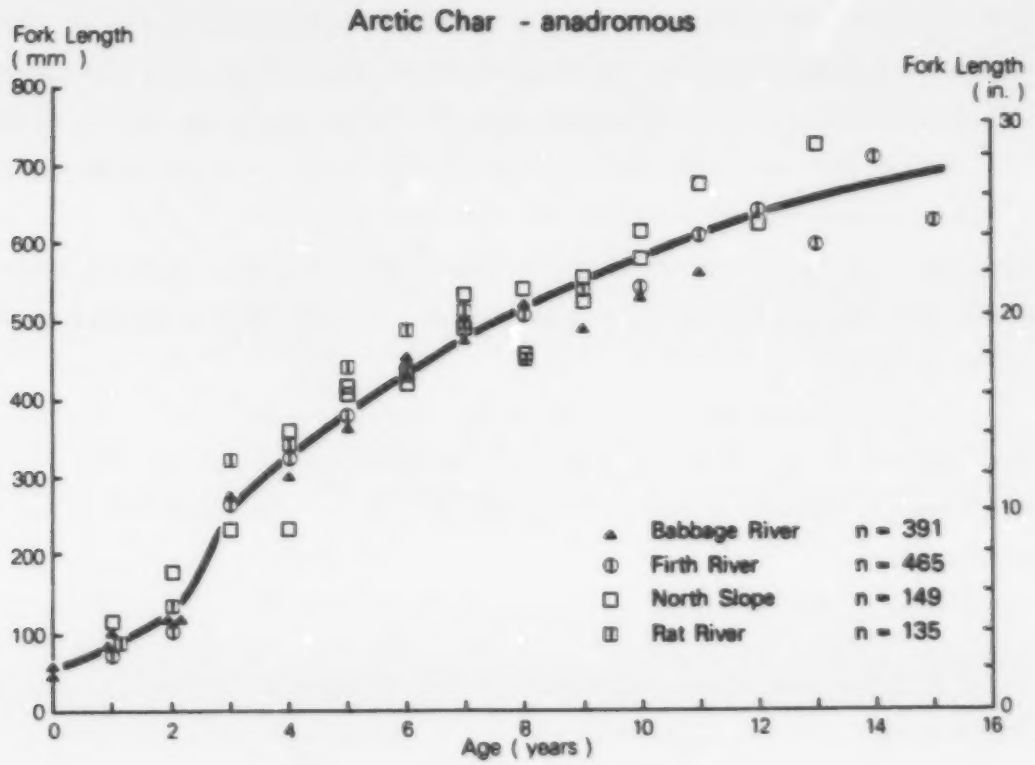


Figure 28. Growth Curve for Anadromous Arctic Char in the Delta Region.

lower Babbage River also feed on fish, fish eggs and adult forms of terrestrial insects. Lake-dwelling char appear to feed on a wide variety of invertebrates.

Growth and Age

Age-length data for anadromous and resident Arctic char in the Delta Region are shown in Figures 28 and 29. Anadromous char grow rapidly after they become smolts and feed at sea. Between three and ten years of age anadromous fish grow about twice as fast as resident males that remain in freshwater, and resident lake-dwelling and land-locked fish. Very few live over ten years. Lake-dwelling char in the Delta show a growth rate similar to that of two populations of land-locked char in Alaska. The oldest migratory anadromous char recorded from the Delta Region was estimated to be fifteen years and was taken from the Firth River, and the longest was 780 mm (31 in), taken from the North Slope Drainage. The oldest char from

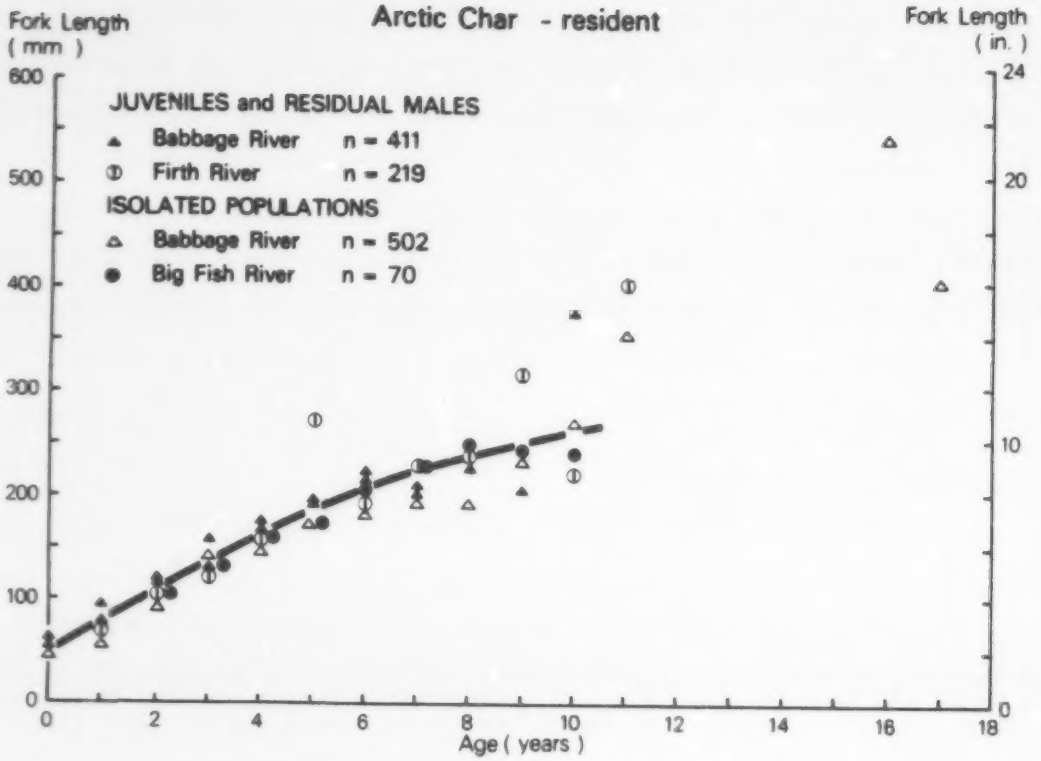


Figure 29. Growth Curve for Resident Arctic Char in the Delta Region.

land-locked populations was estimated to be seventeen years old and the longest was 547 mm (22 in); both were taken from the upper Babbage River.

6.10 Burbot

Introduction

The burbot, or loche *(Lota lota)*, generally prefers deep lakes, but in the north it is also found in rivers and streams and in brackish coastal waters. In the Delta Region the burbot occurs in the Yukon Drainage, in the North Slope Drainage west to the Blow River, throughout the Mackenzie Drainage, and in the Eastern Coastal Drainage. In coastal waters it occurs from Herschel Island to Atkinson Point. The burbot spawns in late fall and early winter.

Movements

Studies from the Mackenzie River in the Delta Region have indicated a movement from mid-August to late September out of delta lakes and channels into creeks that are tributaries to

main delta channels. During October and November, feeding burbot congregate at stream mouths. Local fishermen report that by late October there are upstream movements through the Delta presumably to spawning areas. Burbot tagged in Jackfish Creek near Aklavik in September 1972 were caught upstream in the Peel Channel from September through November 1973. Increases in catches of burbot were recorded in the Arctic Red River area in the fall. However, grayling were common in the stomachs of burbot captured at that time, and the higher numbers of burbot in the area may be related to migrations of Arctic grayling. Some burbot overwinter in the lower Delta, however, there is no information on other overwintering areas or post-spawning movements in the Delta Region.

Reproduction

There is almost no information on burbot reproductive biology in the Delta Region. In the Mackenzie River system fish first reach sexual maturity at six to eight years in the lower Delta. Spawning is known to occur in clear tributary streams and shallow areas of lakes; the exact spawning period is unknown, but spawning probably takes place in late fall or early winter under ice. Known spawning areas occur in the Big Fish River and Travaillant Lake, and spawning is suspected in the lower Delta, and in the Rengleng River, which is an eastern tributary of the Mackenzie River near Arctic Red River. Fish spawn in shallow water over a sand or gravel substrate. Eggs overwinter and fry emerge in the spring. Young-of-the-year and yearlings are found along rocky shores or in weedy areas of streams in the upper Delta, and in shallow turbid lakes in the lower Delta.

Food Habits

Burbot feed mainly on fish, including pike, whitefish, suckers, sticklebacks and grayling, trout-perch and sculpin. Small individuals of their own species are also taken. Young burbot feed on insect larvae and zooplankton; as they become older they prey increasingly on fish.

Growth and Age

Age-length data for burbot from the Delta Region are shown in Figure 30. The rate of growth in these areas is faster than that for burbot upstream in the Mackenzie River at Fort Simpson and Norman Wells. The oldest and longest burbot recorded for the Delta Region was estimated to be nineteen years old, and was 1,000 mm (39 in) long; it was taken from Arctic Red River.

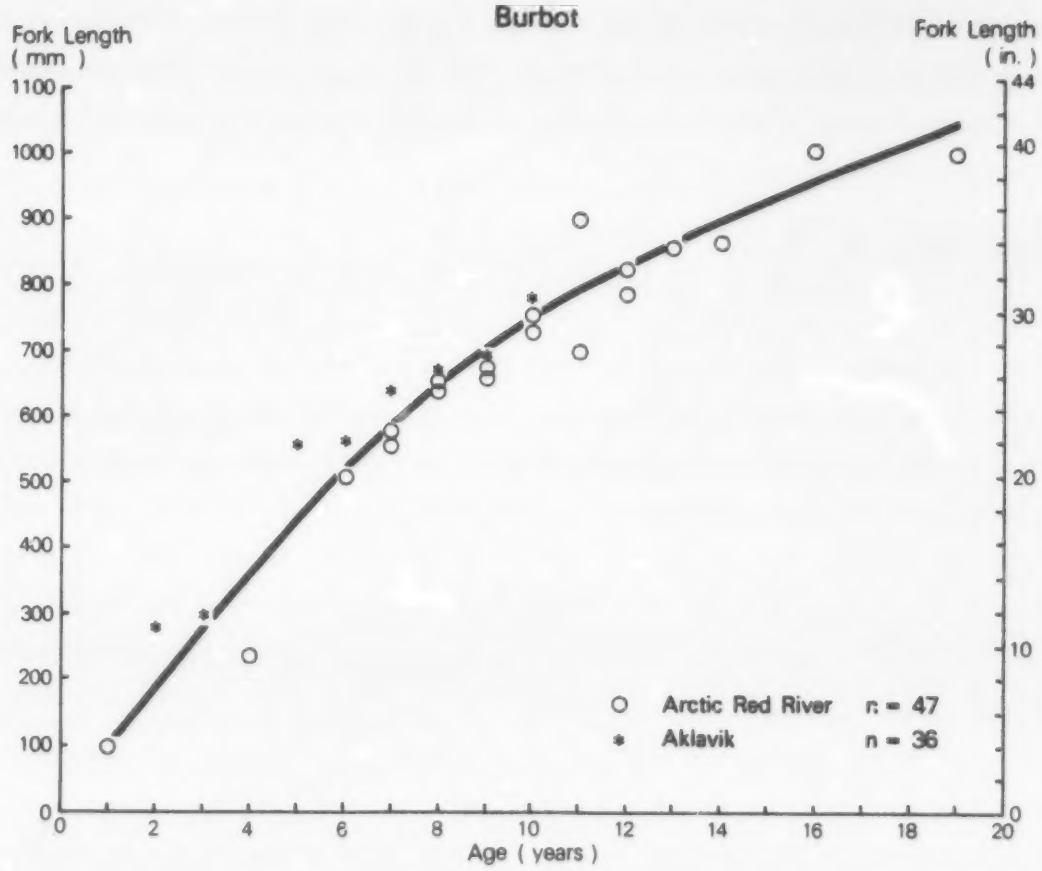


Figure 30. Growth Curve for Burbot in the Delta Region.

6.11 Annotated List of Species

PETROMYZONTIDAE Lampreys

Arctic Lamprey *Lampetra japonica*

The Arctic lamprey is found in fresh and salt water in Eurasia, from Lapland and the upper reaches of the Ob' River east to Kamchatka and south to Japan and Korea; and in North America, from Alaska, the Mackenzie River Drainage, and along the arctic coast of North America east to the Anderson River. In the Delta Region this species occurs in the Yukon, the Mackenzie and the Eastern Coastal drainages, and possibly in the North Slope Drainage. It also occurs in coastal waters from Herschel Island to Toker Point. There are two forms of Arctic lamprey, an

anadromous parasitic form and a smaller, freshwater, possibly non-parasitic form. Lampreys spawn from late May to early July in the Mackenzie and Anderson rivers. Their movements in the Delta Region are poorly known. In coastal waters lampreys have been found attached to smelt, inconnu, herring and Arctic char.

HIODONTIDAE Mooneyes

Goldeye *Hiodon alosoides*

The goldeye is found in quiet, turbid waters of large rivers, and in the muddy shallows of lakes. It occurs throughout the interior of North America from the Mackenzie Delta and southern Ontario and Quebec, south to Louisiana and Alabama. In the Delta Region this species has been recorded only from Aklavik, and from near Point Separation. Goldeye feed primarily on fishes and insects.

CLUPEIDAE Herrings

Herring *Clupea harengus*

The herring usually occurs in salt or brackish waters, but at times enters freshwater. It is found in Arctic waters from the Laptev Sea (Lena Delta), east to the Beaufort Sea, and from west Greenland east to the White and Barents seas, in the North Pacific Ocean south to Korea and California, and in the North Atlantic Ocean south to North Carolina and Spain. In the Delta Region this species occurs in the Beaufort Sea from Herschel Island to Cape Bathurst, including the Mackenzie estuary where it is able to tolerate the wide seasonal salinity and temperature ranges. Herring in the Beaufort Sea make inshore migrations in early summer, possibly for spawning. During mid-July many young herring have been caught along Tuktoyaktuk Peninsula, but in the fall they seek deeper water. In the Delta Region herring feed on plankton, small fishes and invertebrates.

ESOCIDAE Pikes

Northern Pike *Esox lucius*

The northern pike is widely distributed in lakes and rivers throughout Eurasia, from the Arctic coast south to the Dead and Caspian seas and Lake Baikal, and throughout northern North America, south to the north central United States. In the Delta Region, this species is found

throughout the Yukon and Mackenzie drainages, and in the North Slope and Eastern Coastal drainages. It has been reported in coastal locations only in waters of low salinity. A detailed account of the biology of this species is given on page 150.

SALMONIDAE Whitefishes, Graylings, Trouts, Chars, and Salmons

Coregoninae Whitefishes

Lake Cisco *Coregonus artedii*

The lake cisco, or lake herring, is found across Canada from western Mackenzie District and Alberta east to Labrador and Quebec, and south to the north central United States. In the Delta Region this species has been recorded from the Mackenzie and the Anderson River systems. Although lake cisco are usually reported to be lake inhabitants most lake cisco along the Mackenzie River have been captured at the mouths of tributaries. Spawning probably occurs in late fall over sandy or gravelly shallows. Food consists primarily of plankton, insect larvae and other invertebrates and young fishes.

Arctic Cisco *Coregonus autumnalis*

The Arctic cisco is an anadromous species which occurs in offshore regions, coastal waters, and lower parts of Arctic rivers from the White Sea region to Coronation Gulf. In the Delta Region this species is found in the lower reaches of large rivers in the North Slope Drainage, throughout the Mackenzie Drainage, and possibly in the Eastern Coastal Drainage. It is found in the coastal waters of the southeastern Beaufort Sea from Herschel Island to Cape Bathurst. A detailed account of the biology of this species is given on page 154.

Lake Whitefish *Coregonus clupeaformis*

The lake or humpback whitefish is found in lakes or large rivers throughout Alaska, Canada, and the Great Lakes basin in the United States. In the Delta Region, this species is found in all drainages and along the coast at least from Stokes Point to Atkinson Point. West of Kay Point, coastal lake whitefish are restricted to river estuaries and lagoons. A detailed account of the biology of this species is given on page 156.

Bering Cisco *Coregonus laurettae*

The Bering cisco is suspected to occur in extreme northeastern Siberia, and in North America is restricted to the rivers and coastal waters of western and northern Alaska. The

presence of this species in the Delta Region is unconfirmed. Three juvenile cisco captured in the Willow River system of the Mackenzie Drainage were thought to be Bering cisco; however, their small size prevented positive identification.

Broad Whitefish *Coregonus nasus*

The broad whitefish is found in fresh and brackish waters of arctic drainages. It occurs in northern Eurasia from the White Sea to the Bering Strait, and in North America throughout Alaska, the Yukon, and east along the coast of the Northwest Territories to Coronation Gulf. In the Delta Region, this species is found in all drainages and along the coast from Herschel Island to Toker Point. A detailed account of the biology of this species is given on page 158.

Least Cisco *Coregonus sardinella*

The least cisco is found in coastal waters and inland lakes and rivers of Eurasia from the White Sea to the Bering Strait, and in North America from western Alaska to the Queen Maud Gulf. In the Delta Region, this species is present in the Yukon and North Slope drainages, throughout the Mackenzie Drainage, and in Parsons Lake in the Eastern Coastal Drainage. It is found in coastal waters of the southeastern Beaufort Sea, from Herschel Island to Atkinson Point. A detailed account of the biology of this species is given on page 161.

Round Whitefish *Prosopium cylindraceum*

The round whitefish is found in fresh and brackish waters. It occurs in Siberia from the Yenisei River to the Bering Strait and Kamchatka Peninsula, and in northern North America from Alaska to Labrador and New England. In the Delta Region this species is present in the Yukon and North Slope drainages, throughout most of the Mackenzie Drainage, and in the Anderson River in the Eastern Coastal Drainage. It occurs primarily in shallow areas of lakes and clear streams, but also in brackish water in the mouth of the Mackenzie River. Round whitefish spawn in the fall along lakeshores or in streams. They feed mainly on benthic invertebrates and fish eggs.

Inconnu *Stenodus leucichthys*

The inconnu is found in arctic drainages of northern Asia from the White Sea east to the Bering Strait and south to northern Kamchatka, and in North America in Alaska, the Yukon, and the western Northwest Territories. In the Delta Region, this species is known from the Yukon Drainage, from at least one coastal lake near Philips Bay in the North Slope Drainage, throughout

the Mackenzie Drainage, and east to the Anderson River in the Eastern Coastal Drainage. It is also common in coastal waters from Herschel Island to the Tuktoyaktuk Peninsula. A detailed account of the biology of this species is given on page 162.

Thymallinae Graylings

Arctic Grayling *Thymallus arcticus*

The Arctic grayling is found in northern freshwater drainages. It occurs in Eurasia from the Kara and Ob' Rivers east to the Chukotsk Peninsula and Mongolia, and in North America throughout Alaska and northern Canada east of Hudson Bay. This species is widespread in the Delta Region, occurring in all of the drainages, and in some estuarine waters including the Mackenzie Estuary. A detailed account of the biology of this species is given on page 166.

Salmoninae Trouts, Chars, and Salmons

Pink Salmon *Oncorhynchus gorbuscha*

The pink salmon is found in arctic coastal waters from the Laptev Sea east to the Beaufort Sea, and along the coasts of the North Pacific Ocean south to Japan and California. It has been introduced in Europe and the Great Lakes. In the Delta Region this species is rare, there are records only from the Mackenzie Delta and Tuktoyaktuk. In Alaska, spawning occurs in August and September, generally in small streams over gravel substrate. While at sea, pink salmon feed on shrimp, squid, other invertebrates and small fishes.

Chum Salmon *Oncorhynchus keta*

The chum salmon is found in arctic coastal waters from the Laptev Sea east to the Mackenzie River, and along the coasts of the North Pacific Ocean south to Korea and California. In the Delta Region, this species is found only in the Yukon and Mackenzie drainages. It is known to ascend the Mackenzie River as far as Great Slave Lake. Spawning migrations up the Yukon and Mackenzie rivers usually begin in July and August, and spawning usually occurs in riffles over coarse gravel or rocks. At sea, chum salmon feed on small invertebrates, squid and small fishes.

Coho Salmon *Oncorhynchus kisutch*

The coho salmon inhabits coastal regions in the North Pacific Ocean from California and Japan, north to Bering Strait; it ascends large rivers and their tributaries to spawn. It has also been introduced into lakes in North America. This species is present in the Porcupine River near Old Crow, but its occurrence in the Delta Region is unconfirmed. In freshwater, young coho feed mainly on insect larvae; at sea, coho feed on shrimp, squid and small fishes.

Chinook Salmon *Oncorhynchus tshawytscha*

The chinook salmon occurs in coastal waters and ascends large rivers in the North Pacific Ocean from Japan and California north to the Bering Strait. It has also been widely introduced into eastern Canada, the United States, Europe, South America, Australia, and New Zealand. This species occurs in the Porcupine River, but its presence in the Delta Region is unconfirmed although there have been unverified reports of chinook salmon from the Mackenzie Delta. In freshwater, young chinook feed on small fishes and invertebrates.

Arctic Char *Salvelinus alpinus*

The Arctic char is found in northern circumpolar coastal marine waters, lakes, and rivers, south to the Bering Sea, and south in the North Atlantic Ocean to the Gulf of St. Lawrence and southern Scandinavia. Isolated populations are found in eastern Canada, New England, and Europe. In the Delta Region this species is most abundant in the North Slope Drainage and fairly common throughout the Mackenzie Drainage, particularly west of the Mackenzie Delta, and is less common in the Eastern Coastal Drainage. It occurs in coastal and estuarine waters from Herschel Island to Tuktoyaktuk. A detailed account of the biology of this species is given on page 168.

Dolly Varden *Salvelinus malma*

The Dolly Varden is found in coastal waters and in freshwater lakes and rivers in the North Pacific Ocean from California and Korea north to Bering Strait. The presence of this species has not been confirmed in the Delta Region, although there are numerous unverified reports of Dolly Varden in the headwaters of the Peel River and in other Mackenzie River tributaries that rise in the Richardson and northern Mackenzie mountains, including the Big Fish, Peel, and Arctic Red rivers, and in the Mackenzie Delta.

Lake Trout *Salvelinus namaycush*

The lake trout is found primarily in lakes and large clear rivers throughout northern North America; it has been widely introduced into the United States, Sweden, New Zealand, and South America. In the Delta Region, this species is present in the North Slope, Mackenzie, and Eastern Coastal drainages. Spawning probably occurs in late summer and early fall, usually over rocky shoals in lakes; however, river spawning has also been recorded. Adults feed on other fish, mainly cisco, whitefish and sticklebacks, and on invertebrates.

OSMERIDAE Smelts

Pond Smelt *Hypomesus olidus*

In the Arctic, the pond smelt occurs mainly in freshwater lakes and streams. It is found in northwestern Asia from northern Japan north to Bering Strait and west to the Alazya River in Siberia; there is an isolated population in the Kara Sea Drainage. In North America it is known only from western Alaska and the Peel and Mackenzie rivers in northwestern Canada. In the Delta Region this species is present in Shallow Bay in the Mackenzie Estuary, throughout the Mackenzie Drainage and in at least two small lakes in the North Slope Drainage. In North Slope lakes, pond smelt spawn in early July immediately after breakup. Pond smelt feed mainly on zooplankton, insects and benthic invertebrates.

Capelin *Mallotus villosus*

The capelin is a marine fish, coming inshore only to spawn. It is found in offshore and coastal waters from Bering Strait east to Coronation Gulf, from Hudson Bay and Greenland east to the Kara Sea, and in the Lena River Delta. It is also found in the North Pacific Ocean south to Korea and British Columbia and in the North Atlantic Ocean south to Maine and Norway. In the Delta Region this species is known only from Herschel Island and Stokes Point. Capelin usually spawn from late summer to fall over coarse sand or fine gravel beaches. They feed mainly on shrimp, marine worms, other invertebrates and small fishes.

Rainbow Smelt *Osmerus mordax = Osmerus eperlanus*

The rainbow smelt is an anadromous species commonly inhabiting coastal waters. It is found in the Arctic Ocean from the White Sea east to Coronation Gulf, in the North Pacific Ocean from Korea and British Columbia north to Bering Strait, in the western North Atlantic

Ocean from New Jersey to Labrador, and in the eastern North Atlantic Ocean from France to Sweden. In the Delta Region this species is known from the Firth River estuary in the North Slope Drainage, from the Mackenzie Estuary to Arctic Red River in the Mackenzie Drainage, from the Anderson River in the Eastern Coastal Drainage, and from Herschel Island. There is little information on spawning in the Delta Region, but smelt probably spawn in running waters over stones or gravel in May or June. Catches at Arctic Red River indicate a spawning migration up the Mackenzie River just after breakup, followed by a return to the sea. Smelt feed principally on crustaceans and small fishes.

CYPRINIDAE Minnows and Carps

Lake Chub *Couesius plumbeus*

The lake chub is found across northern North America from eastern Alaska throughout mainland Canada and into the northern United States. In the Delta Region it is known from the Yukon Drainage, throughout the Mackenzie Drainage, and from the upper Anderson River system in the Eastern Coastal Drainage. The lake chub is found in a variety of habitats ranging from clear streams and tributary mouths to the turbid waters of the Peel, Arctic Red, and Mackenzie rivers. Spawning probably occurs in the spring, however, in the northern part of its range, specimens ready to spawn have been caught as late as August. Lake chub feed mainly on insects.

Flathead Chub *Platygobio gracilis*

The flathead chub is found in western North America from the Mackenzie River Delta south to Arkansas and New Mexico. In the Delta Region this species is common in swift muddy waters of the main channels of the Mackenzie Delta above Aklavik. In other regions the flathead chub is thought to make a spring spawning migration up small streams. However, in the Arctic Red River area, spawning probably occurs in late July. The diet of flathead chub is diverse, but consists mainly of aquatic and terrestrial insects.

Emerald Shiner *Notropis atherinoides*

The emerald shiner is found in lakes and large rivers in North America from the lower reaches of the Mackenzie River east across Canada to Quebec and southward, east of the Rocky Mountains and west of the Appalachians to the Gulf Coast of Alabama and Texas. In the Delta Region this species has been reported only from the Mackenzie River near Point Separation.

Spawning habits in the Delta Region are not known. Emerald shiners feed mainly on plankton and insect larvae.

Spottail Shiner *Notropis hudsonius*

The spottail shiner is found primarily in large clear lakes, but also occurs in large, rather turbid rivers. It occurs in North America from the Mackenzie River Drainage east to Quebec and south into the north central United States and the Appalachian Mountains. In the Delta Region this species is known only from the Mackenzie River, as far north as the Rengleng River, above the Arctic Red River. Spawning habits in the Delta Region are not known. Food consists primarily of insect larvae.

Northern Redbelly Dace *Chrosomus eos*

The northern redbelly dace is found in boggy lakes, creeks, and ponds. It occurs in western North America from the Mackenzie Delta south to Colorado and east through the Great Lakes Basin to the Maritimes and New England. In the Delta Region this species has been reported only from the Mackenzie Delta at Point Separation and from Arctic Red River. Spawning habits in the Delta Region are not known. Dace feed mainly on plants, especially filamentous algae.

Finescale Dace *Chrosomus neogaeus*

The finescale dace is found in bog ponds, lakes, and streams, in the Mackenzie River Drainage of northwestern North America, in the west central United States, and in northeastern North America from Hudson Bay and the Great Lakes Basin east to New Brunswick and Maine. In the Delta Region this species has been reported only from the vicinity of Arctic Red River. Spawning habits in the Delta Region are not known. Finescale dace feed mainly on insects.

Longnose Dace *Rhinichthys cataractae*

The longnose dace occurs in running waters and is often found in rocky sections of tributaries. It is found from the Pacific Coast across Canada and the northern United States to Quebec and New England, north through the Mackenzie River system and south in the Rocky Mountains and Appalachians. In the Delta Region this species is found in the lower Mackenzie River to the upper Mackenzie Delta. Spawning habits in the Region are not known. Longnose dace feed mainly on insect larvae.

CATOSTOMIDAE Suckers

Longnose Sucker *Catostomus catostomus*

The longnose sucker has a high tolerance for turbidity and has been taken in greatest numbers from slow waters; it is also present in brackish water near river mouths. It is found in northeastern Siberia, throughout most of mainland Canada, and across the northern United States. In the Delta Region this species is known from the Yukon Drainage, throughout the Mackenzie Drainage, and from the Horton and Anderson rivers in the Eastern Coastal Drainage. It is also found rarely along the coast from Shingle Point to Toker Point. Spawning occurs after breakup, from late May to mid-June, in tributaries and shallow lakes over a gravel or rocky bottom. Longnose suckers feed mainly on crustaceans and aquatic insects.

White Sucker *Catostomus commersoni*

The white sucker is found throughout much of North America; from the Mackenzie River east to Labrador and Nova Scotia and south to New Mexico, Oklahoma, and Georgia. In the Delta Region this species has been reported from Arctic Red River, however, no specimens were preserved and its occurrence has not been confirmed. In the northern limits of its range the white sucker is restricted to warm shallow water and it feeds principally on insect larvae.

PERCOPSIDAE Trout-Perches

Trout-Perch *Percopsis omiscomaycus*

The trout-perch is found in the Porcupine and Mackenzie rivers in northwestern North America, throughout Canada east of the Rockies to southern Quebec, and in the north central United States. In the Delta Region this species is present in the Porcupine River, in the Yukon Drainage and throughout the Mackenzie Drainage, in diverse habitats ranging from clear streams and tributary mouths to turbid water. The trout-perch spawns in summer in shallow waters of slow, clear streams or along lake beaches. In the Mackenzie Drainage catches of trout-perch were noted to be quite high until late August, after which time the numbers decreased. Abundance was greatest in the Arctic Red River area and decreased to the south. Trout-perch feed at night on aquatic insects, snails, clams, and crustaceans. During the day they move into deeper waters and may in turn be fed on by lake trout; in this way trout-perch may serve to transport nutrients from productive shallow waters to less productive deep waters.

GADIDAE Codfishes

Arctic Cod *Boreogadus saida*

The Arctic cod occurs in northern circumpolar regions in salt water and is known to enter fresh waters. It is found throughout the Arctic, in the Atlantic Ocean south to the Gulf of St. Lawrence, and in the northern Bering Sea. In the Delta Region this species occurs along the coast from Herschel Island to Shingle Point, and from Kugmallit Bay to Warren Point; it also occurs in the Eskimo Lakes. In Kugmallit Bay, adults were caught in warm water of low salinity while fry were taken at lower temperatures and higher salinities, indicating that young have a lower tolerance of estuarine conditions than adults. Arctic cod fry were found to be abundant in the Cape Parry area in 1973, and are thought to be a significant component of the diet of beluga.

Saffron Cod *Eleginus gracilis*

The saffron cod is found in coastal and offshore waters, in estuarine waters, as well as in freshwater in the lower parts of rivers. In the Arctic Ocean it is known from northern Russia and from northeastern Siberia east to Bathurst Inlet, and probably to Simpson Strait. It is also found on the coasts of the North Pacific Ocean from the Yellow Sea north to the Bering Sea, and in the Gulf of Alaska. In the Delta Region this species is found along the coast from Herschel Island to Kugmallit Bay, in the Eskimo Lakes, and probably in Liverpool Bay. Cod taken from Toker Point, Liverpool Bay, and Langton Bay by Anderson in 1913 were probably of this species. Saffron cod are taken by beluga and may be abundant in offshore waters in the Delta Region.

Ogac *Gadus ogac*

The ogac is known from coastal and offshore waters from Point Barrow, Alaska, east to West Greenland, and south to Cape Breton Island. This species has not been recorded from the Delta Region, although a "rock cod" collected by Anderson in Langton Bay may have been an ogac.

Burbot *Lota lota*

The burbot is found in fresh and brackish waters throughout northern Eurasia and northern North America. In the Delta Region this species occurs in the Yukon Drainage, in the Blow River in the North Slope Drainage, throughout the Mackenzie Drainage, and in the Eastern

Coastal Drainage. Along the coast it has been reported from Herschel Island to Atkinson Point. A detailed account of the biology of this species is given on page 171.

ZOARCIDAE Eelpouts

Shulupaoluk *Lycodes jugoricus*

The shulupaoluk occurs in estuarine waters of the Arctic Ocean from the White Sea east to the Chukchi Sea and the western Beaufort Sea. In the Delta Region this species has been recorded only from Herschel Island.

Pale Eelpout *Lycodes pallidus*

The pale eelpout occurs in northern circumpolar waters and from the North Atlantic Ocean south to Labrador and northern Europe. In the Delta Region this species is known only from Herschel Island and Kugmallit Bay off Warren Point.

Arctic Eelpout *Lycodes reticulatus* Threespot Eelpout *Lycodes rossi*

The Arctic eelpout is found in the North Atlantic Ocean south to Nova Scotia, and from Ungava and Hudson bays. The threespot eelpout is known only from the Kara Sea and Spitsbergen. In the Delta Region, eelpout collected near Herschel Island show characteristics of both Arctic eelpout and threespot eelpout; it is not known to which species the Herschel Island specimens belong.

Ribboned Eelpout *Lycodes turneri*

The ribboned eelpout occurs in Arctic waters from the Kara Sea east to West Greenland, the northern Bering Sea, and the western North Atlantic Ocean south to the Gulf of St. Lawrence. In the Delta Region specimens of eelpout have been taken from Herschel Island and have been identified as either ribboned or polar eelpout *(Lycodes polaris)*.

GASTEROSTEIDAE Sticklebacks

Brook Stickleback *Culaea inconstans*

The brook stickleback is found in cool clear waters throughout north central North America from the Mackenzie Delta, northern Manitoba and New Brunswick south to Montana and the Great Lakes Basin. In the Delta Region this species has been recorded only from the vicinity of Arctic Red River. Brook sticklebacks spawn in the spring and feed on insect larvae,

crustaceans, snails, and clams.

Ninespine Stickleback *Pungitius pungitius*

The ninespine stickleback occurs in fresh and coastal waters throughout northern Eurasia and south in western Asia to Japan. In North America it occurs in coastal regions of western and northern Alaska and throughout Canada east of the Rocky Mountains. In the Delta Region this species is found throughout the North Slope, Mackenzie and Eastern Coastal Drainages and along the coast from Herschel Island to eastern Mackenzie Bay, off Richards Island and from Langton Bay. The ninespine stickleback is reported to frequent lakes, slow streams, and tundra ponds, as well as the smaller tributaries of the Mackenzie River. In a tributary of the Rat River spawning was found to occur in late August over a silt substrate. In the lower Delta spawning may occur in spring and summer. Food consists of benthic organisms such as insect larvae, small crustaceans, snails and clams.

COTTIDAE Sculpins

Rough Hookear *Artediellus scaber*

The rough hookear is found in Arctic coastal salt and brackish waters from the Kara Sea east to the Chukchi and Beaufort Seas, and south into the northern Bering Sea. In the Delta Region this species has been recorded only from Herschel Island.

Slimy Sculpin *Cottus cognatus*

The slimy sculpin is found in fresh and brackish waters from extreme northeastern Siberia through most of mainland Canada, the Great Lakes and south to Virginia. In the Delta Region this species is found in the Yukon Drainage, the Eastern Coastal Drainage and in most of the Mackenzie Drainage, as far north as the Big Fish River and Richards Island. It occurs in a variety of habitats ranging from clear streams and tributary mouths to the turbid waters of the Peel and Mackenzie rivers. The slimy sculpin spawns in the Delta Region and feeds primarily on aquatic insects. In the Mackenzie Drainage, sculpin appear to move from small tributaries during July and August into the Mackenzie River, in which they may overwinter.

Spoonhead Sculpin *Cottus ricei*

The spoonhead sculpin is found in freshwater throughout north central and east central Canada and in the Great Lakes basin. In the Delta Region this species occurs in the Mackenzie

Drainage north to the coast and in estuarine waters of eastern Mackenzie Bay. It is primarily a resident of the muddy shallows of the Mackenzie River, although a few are found in lakes. In the Arctic Red River area it has been reported from small creeks, tributary mouths, and larger rivers. In the Mackenzie Delta the spoonhead sculpin is thought to spawn from late June to early July. It feeds primarily on aquatic insects.

Arctic Staghorn Sculpin *Gymnocanthus tricuspis*

The Arctic staghorn sculpin occurs in northern circumpolar coastal waters, in the North Atlantic Ocean south to the Gulf of St. Lawrence, and northern Norway; it may also occur in the Bering Sea. In the Delta Region this species has been recorded only from Herschel Island.

Twohorn Sculpin *Icelus bicornis*

The twohorn sculpin is found throughout Canadian Arctic waters south to Hudson and Ungava bays and eastward at least to the Barents Sea. The only record of this species in the Delta Region is from the Herschel Island area.

Spatulate Sculpin *Icelus spatula*

The spatulate sculpin is found in Arctic coastal waters from the Kara Sea eastward to West Greenland, in the Bering Sea, and in the western North Atlantic Ocean south to Labrador. In the Delta Region this species has been recorded only from the Herschel Island area.

Fourhorn Sculpin *Myoxocephalus quadricornis*

The marine form of the fourhorn sculpin is found in coastal waters and commonly ascends far up rivers. It occurs in northern circumpolar waters, in the northern Bering Sea, and in the North Atlantic Ocean south to Labrador and the Baltic Sea. The land-locked freshwater form is found in lakes across northern Eurasia and Alaska, in the Canadian Arctic Islands, and from northwestern Mackenzie District to the Great Lakes. In the Delta Region the marine form occurs along the coast and in coastal lagoons from Herschel Island to Shingle Point and from the Mackenzie Estuary to Atkinson Point. The marine form has also been reported to ascend the Babbage and Firth rivers in the North Slope Drainage, and the Mackenzie River as far as Arctic Red River. In the Delta Region the marine form spawns in late fall and winter, whereas the land-locked form appears to spawn in summer. Marine form sculpin feed largely on benthic organisms, principally crustaceans, although adults also take some fish including small members

of their own species.

Arctic Sculpin *Myoxocephalus scorpioides*

The Arctic sculpin is found in Arctic coastal waters from the East Siberian Sea to West Greenland, in the Bering Sea, and in the western north Atlantic south to Newfoundland. The only record of this species from the Mackenzie Delta Region is of a specimen collected at Herschel Island in 1960.

Ribbed Sculpin *Triglops pingeli*

The ribbed sculpin occurs in northern circumpolar waters, in the North Pacific Ocean to northern Japan and Washington, ar.d in the North Atlantic Ocean to Massachusetts and Europe. In the Delta Region this species has been recorded only from the Herschel Island area.

AGONIDAE Poachers

Arctic Alligatorfish *Aspidophoroides olriki*

The Arctic alligatorfish is found in marine waters from the Barents Sea east to the Bering and Beaufort seas, in Hudson and Ungava bays, and in the western North Atlantic from West Greenland to Labrador. In the Delta Region this species is known only from Herschel Island.

CYCLOPTERIDAE Lumpfishes and Snailfishes

Bartail Seasnail *Liparis herschelinus*

The bartail seasnail is known only from marine waters in the western Beaufort Sea, but may extend west to the Laptev Sea. It is possible, however, that the bartail seasnail is a subspecies of the striped seasnail *(Liparis liparis)*, which is found in northern circumpolar waters and in the North Atlantic Ocean south to Virginia and northern France. In the Delta Region this species has been recorded only from Herschel Island.

Gelatinous Seasnail *Liparis koefoedi*

The gelatinous seasnail probably occurs in northern circumpolar waters, but has not been recorded from the Kara and Chukchi Seas and the central Canadian Arctic. In the Delta Region this species has been recorded only from Herschel Island. There is one record of *Liparis* spp. from eastern Mackenzie Bay, however, it was not identified to the species level.

PERCIDAE Perches

Walleye *Stizostedion vitreum*

The walleye is found throughout central North America from the Mackenzie Delta and northern Manitoba and Quebec, south to Arkansas and Alabama. In the Delta Region this species is known only from the Mackenzie Drainage; it is rare in the Mackenzie Delta, but becomes more common towards the Arctic Red and Peel rivers. Walleye are relatively abundant at the mouths of fast flowing rocky streams with low turbidity. In the Delta Region spawning occurs after river ice breaks up during late May and is believed to occur in tributaries to the lower Mackenzie River. Walleye feed primarily on fish, especially suckers.

STICHAEIDAE Pricklebacks

Blackline Prickleback *Acantholumpenus mackayi*

The blackline prickleback occurs in the Bering and Beaufort seas. In the Delta Region this species is known only from Tuktoyaktuk Harbour and the outer reaches of the Eskimo Lakes.

Slender Eelblenny *Lumpenus fabricii*

The slender eelblenny is found in the Barents Sea, Sea of Okhotsk, western Bering Sea, Chukchi Sea, Beaufort Sea, Hudson Bay, and off the coast of West Greenland. In the Delta Region this species has been reported only from Herschel Island.

AMMODYTIDAE Sand Lances

Stout Sand Lance *Ammodytes hexterus*

The stout sand lance occurs in marine waters along the coasts of northern and arctic Eurasia, along the Pacific coast of North America from California to Alaska, in the Chukchi and Beaufort Seas, in Hudson Bay, and possibly along the coast from West Greenland to Labrador. In the Delta Region this species has been recorded from Herschel Island, Kugmallit Bay, Liverpool Bay, and Langton Bay.

PLEURONICTIDAE Righteye Flounders

Arctic Flounder *Liopsetta glacialis*

The Arctic flounder is found in brackish coastal waters and the lower parts of rivers, but avoids waters of high salinity. It occurs in Arctic coastal waters from the White Sea east to Bathurst Inlet and possibly the Queen Maud Gulf, and in the eastern Bering Sea. In the Delta Region this species is found along the coast and in coastal lagoons at least from Herschel Island to Phillips Bay and from eastern Mackenzie Bay to Liverpool Bay.

Starry Flounder *Platichthys stellatus*

The starry flounder occurs in the North Pacific Ocean from Japan and southern California north to the Bering Strait, and in the Chukchi and Beaufort seas. In the Delta Region this species occurs along the coast and in coastal lagoons from Stokes Point and Phillips Bay and from eastern Mackenzie Bay to Toker Point, and has been reported from Cape Bathurst and Langton Bay.

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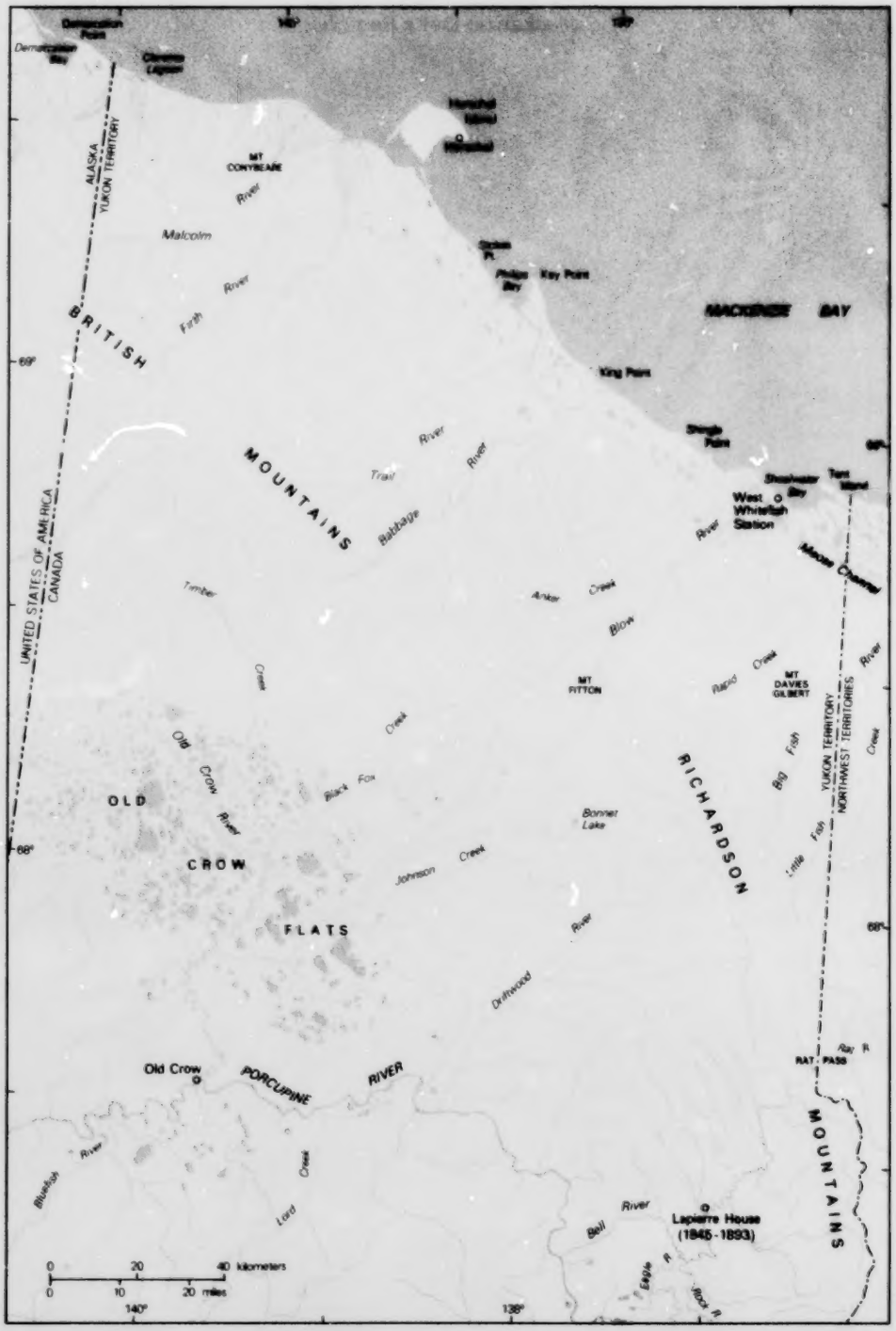
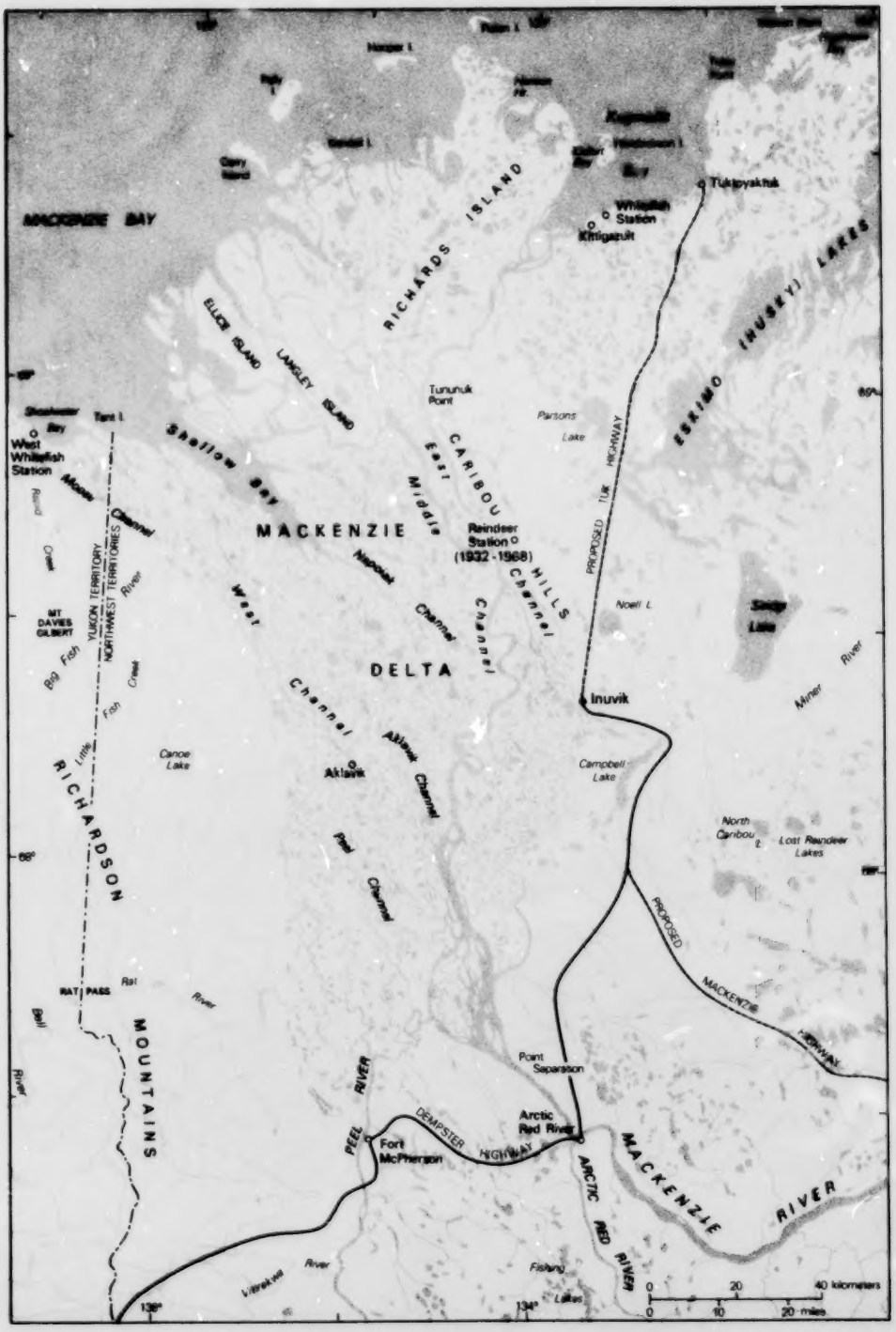
7. APPENDICES

Detailed Map Sheets of the
Mackenzie Delta Region

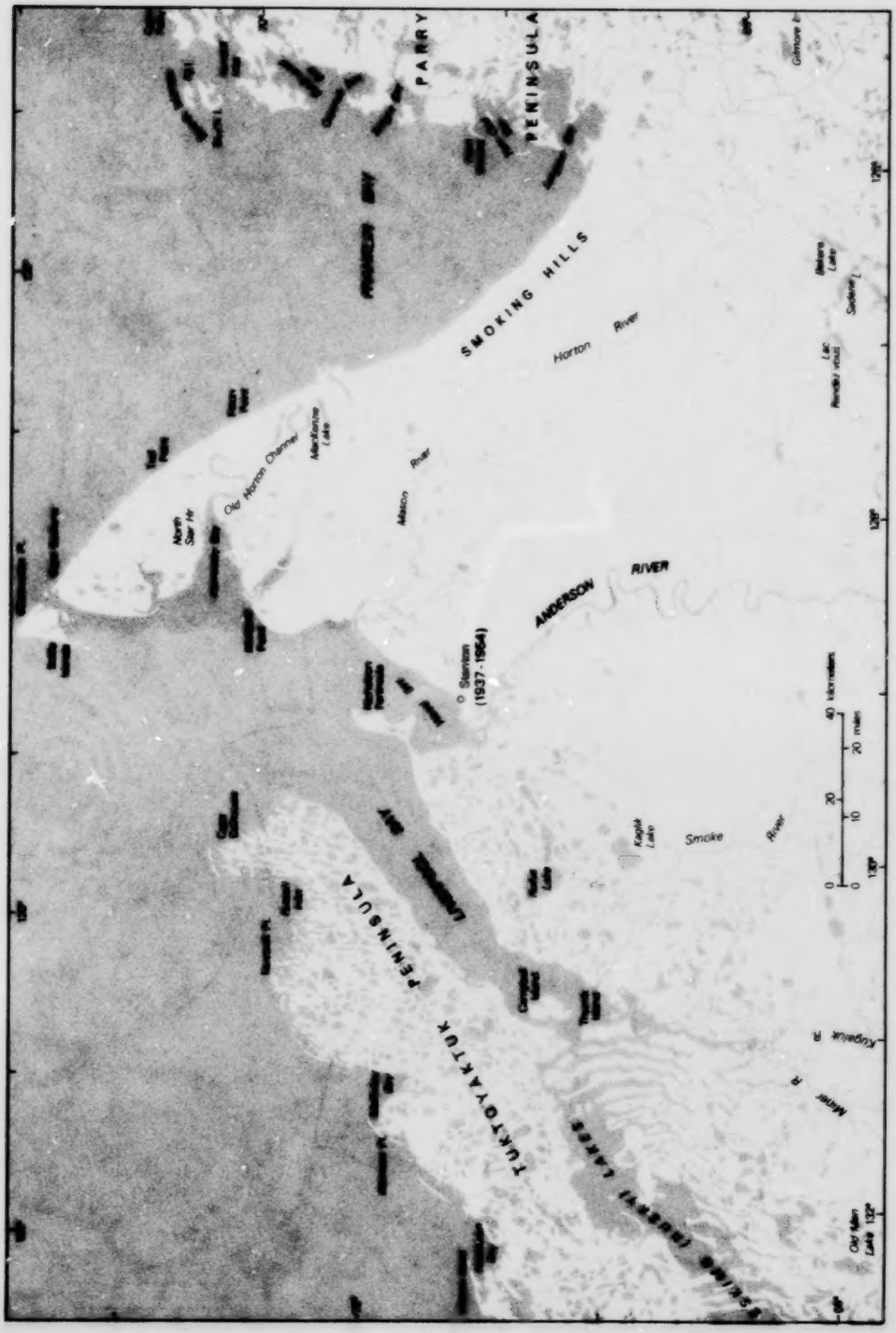
APPENDIX 1


ALASKA
YUKON TERRITORY
BRITISH
UNITED STATES OF AMERICA
CANADA
MT CONYBEARE
Malcolm
River
Firth
River
MOUNTAINS
Babbage
Trail
River
River
Timber
Creek
Old Crow
River
OLD
CROW
FLATS
Black Fox
Creek
Johnson
Creek
Driftwood
River
Old Crow
PORCUPINE
RIVER
Bluefish
River
Creek
Lord
Creek
Bell
River
Lapierre House
(1845-1893)
Eagle R.
Rock R.
Ray R.
RAT PASS
MOUNTAINS
RICHARDSON
Big Fish
Creek
Little Fish
Creek
Bonnet
Lake
Anlor
Creek
Blow
Creek
Rapid
Creek
MT
FITTON
MT
DAVIES
GILBERT
YUKON TERRITORY
NORTHWEST TERRITORIES
River
MACKENZIE BAY
King Point
Kay Point
Phillips Bay
Spoon Pt.
Herschel Island
Qikiqtaruk
Demarcation Point
Demarcation Bay
Clarence Lagoon
Shingle Point
Stokes Point
West Whitefish Station
Mackenzie Channel
Toker Island
0 20 40 Kilometers
0 10 20 miles
140°
136°
69°
68°

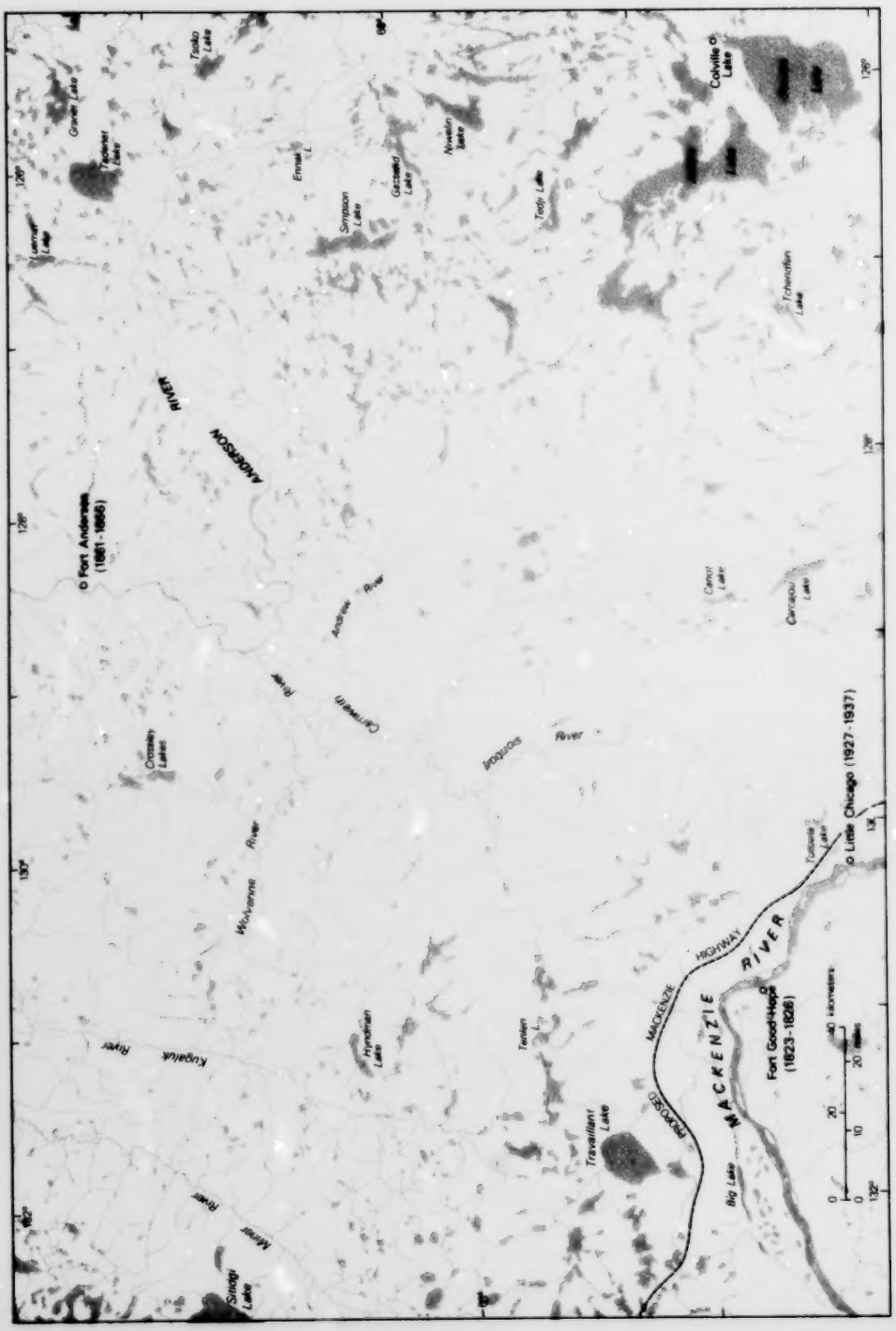
APPENDIX 2


BEAUFORT SEA
RICHARDS ISLAND
ELLICE ISLAND
LANGLEY ISLAND
Shallow Bay
West Whitefish Station
Whitefish Station
Kittigazuit
Tuktoyaktuk
ESKIMO (NUSEY) LAKES
Tununuk Point
Parsons Lake
MACKENZIE DELTA
Middle Channel
East Channel
West Channel
Napoiak Channel
Reindeer Station (1932-1968)
CARIBOU HILLS
PROPOSED TUK HIGHWAY
Noell L
Swim Lake
Inuvik
Miner River
Campbell Lake
Aklavik
Aklavik Channel
Peel Channel
Canoe Lake
North Caribou L
Lost Reindeer Lakes
PROPOSED MACKENZIE HIGHWAY
YUKON TERRITORY
NORTHWEST TERRITORIES
MT DAVIES GILBERT
Big Fish River
Little Fish Creek
RICHARDSON MOUNTAINS
RAT PASS
Rat River
Bell River
Point Separation
Arctic Red River
DEMPSTER HIGHWAY
PEEL RIVER
Fort McPherson
ARCTIC RED RIVER
MACKENZIE RIVER
Fishing Lakes
Little Peel River
0 20 40 kilometers
0 10 20 miles

APPENDIX 3


PARRY
PENINSULA
SMOKING HILLS
Horton River
Old Horton Channel
Mackenzie Lake
Mason River
North Star Arc
ANDERSON RIVER
Stanton (1937-1964)
Knight Lake
Smoke River
TUKTOYAKTUK PENINSULA
Old Man Lake
Kugaruk R.
Marker R.
Gillman B.
Sellaby L.
Lac Renaby
Baloro Lake
0 20 40 Kilometers
0 10 20 Miles
128°
132°

APPENDIX 4


Fort Anderson (1861 - 1866)
ANDERSON RIVER
Arctic Red River
Ontaratio
Peel River
Mackenzie River
Klondike River
Porcupine River
Yukon
Old Crow
Fort Yukon
Fort Good Hope (1823 - 1826)
Little Chicago (1927 - 1937)
MACKENZIE RIVER
MACKENZIE HIGHWAY
Big Lake
Travaillant Lake
Colville Lake
Tsiigehtchic
Inuvik
Aklavik
Tuktoyaktuk
Sitidgi Lake
Hyndman Lake
Tenlen L.
Crossen Lakes
Canyon Lake
Canoe Lake
Tsiigehtchic Lake
Tuktoyaktuk Lake
Emma L.
Simpson Lake
Gossage Lake
Noyelle Lake
Tedy Lake
Trout Lake
Tsiigehtchic Lake
Lennie Lake
Gravel Lake
Tsiigehtchic Lake
0 20 40 Kilometers
0 10 20

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9. GLOSSARY

Amphibians – a class of vertebrates that are intermediate in many respects between fishes and reptiles, eg. frogs, toads.

Anadromous – fish that ascend rivers from the sea at certain seasons for breeding eg. salmon.

Baleen – a horny substance growing in the mouth of toothlesss whales. Also called whalebone. Acts as a seive to collect the krill which constitute the whale's food.

Barrier beaches – a long narrow sandy island lying parallel to shore and built up by the action of the waves, currents, and wind.

Benthic – relating to, or occurring on the bottom underlying a body of water.

Brackish waters – somewhat salty water; less salt than the sea but undrinkable. eg. water in the tidal reaches of a river.

Carnivore – a flesh-eating animal. An order of mammals.

Clutch – a nest of eggs or a brood of chicks; eggs laid by a bird at regular consecutive intervals without intervening longer pauses.

Crustacean – an animal of the class Crustacea which comprises the majority of the marine or freshwater arthropods (lobster, shrimp, crab, water fleas, etc.) and some land forms (eg. wood lice).

Drift ice – sea or lake ice broken apart by winds and currents.

Ecosystem – an ecological community considered together with the nonliving factors of its environment as a unit.

Estuarine – relating to, or formed in an estuary.

Estuary – a water passage (eg. the mouth of a river) where the tide meets the current of a stream.

Feral – a domesticated animal that has reverted to the wild state.

Invertebrates – a division of the animal kingdom for animals without a backbone.

Lead – a channel of water through a field or floe of ice.

Pack ice – sea ice formed into a chaotic mass by the crushing together of pans, floes and brash.

Patterned ground – a general term for any ground surface or surficial soil material exhibiting a discernible, more or less ordered and symmetrical, micro-physiographic pattern.

Photosynthesis – the formation of carbohydrates from carbon dioxide and a source of hydrogen (eg. water) in green plants exposed to light.

Phytoplankton – plankton consisting of plant life.

Plankton – the passively floating or weakly swimming animal and plant life of a body of water consisting chiefly of minute plants (eg. blue-green algae) and minute animals (eg. protozoans and many small crustaceans.

Polygon – a type of patterned ground consisting of a closed, roughly equidimensional figure bounded by several sides, commonly more or less straight but some, or all, of which may be irregularly curved. Polygon, high centre – a polygon having a centre that is higher than its margins. Polygon, low centre – a polygon having a centre lower than its margins. Polygon, nonsorted – patterned ground whose mesh is dominantly polygonal and lacks a border of stones.

Polynya – an area of open water completely surrounded by sea ice. Thus different from a lead, which may lie between land and ice.

Rhizomes – a horizontal stem growing beneath the surface of the ground. It is often much enlarged and may contain large reserves of food material.

Riparian – located on the bank of a watercourse eg. a river or stream.

Vertebrate – animals with backbones.

Zooplankton – animal life of the plankton.

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